

■ PROJECTS ■ THEORY ■ APPLICATIONS ■ CIRCUITS ■ TECHNOLOGY

NUTS  
AND  
VOLTS

# NUTS AND VOLTS

www.nutsvolts.com  
JANUARY 2007

EVERYTHING FOR ELECTRONICS

## Build A Ring Flash For Macro Photography

■ **Interfacing  
Standards: RS-232**

■ **Getting Started  
With PICAXE  
Microcontrollers**

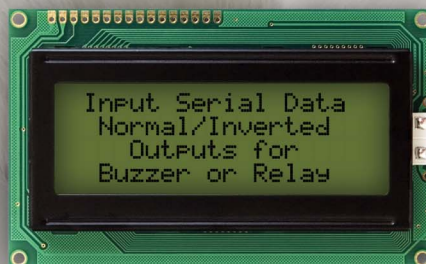
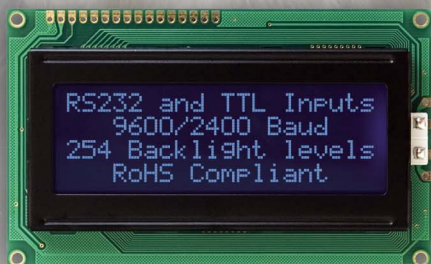
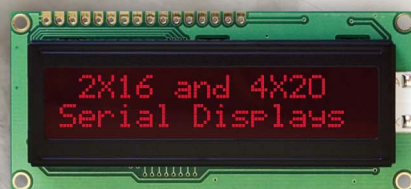
■ **Charge All  
Battery Charger  
Switch**

■ **Ready... Set... Code!**



THESE ARE THE REAL DEAL

Serial**LCD**™



COLOR MAKES THE ORDINARY... **EXTRAORDINARY!**

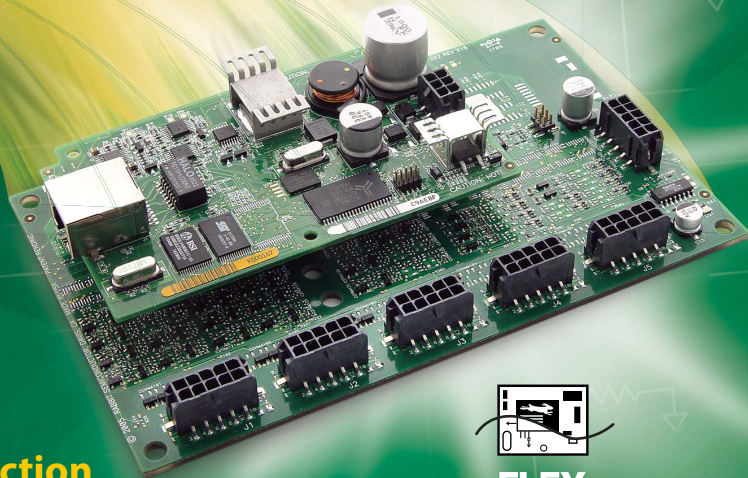


NetMedia Inc., 10940 N Stallard Pl, Tucson Arizona 85737 tel.520.544.4567 fax.520.544.0800 [www.BasicX.com](http://www.BasicX.com)



# RabbitFLEX

## A New Way To Customize



- ▶ **Click-to-ship in 5 days!**
- ▶ **Pay only for what you need**
- ▶ **Revision friendly**
- ▶ **Perfect for prototype and production**



RabbitFLEX™ is an unique build system that gives you the power to develop custom boards without the hassle and the cost. The RabbitFLEX simple-to-use web interface allows you to choose from numerous options such as digital I/O, analog I/O, serial ports, and Ethernet connections on your custom board. Just configure and buy online and our patent pending manufacturing process will deliver your solution in a matter of days. With RabbitFLEX you will reduce design risk, manufacturing cost, and development time.

**Start developing now by ordering the RabbitFLEX Tool Kit and your own custom RabbitFLEX board. Take your solution to the next level.**

Configure and Buy Online  
**[www.myrabbitflex.com](http://www.myrabbitflex.com)**

Quick-Turn Boards Range From  
**\$149-\$279**

RabbitFLEX Tool Kit  
**\$199**

### Test Drive RabbitFLEX

Build your custom RabbitFLEX board online. Add a tool kit to your order for a complete development system including Dynamic C®.

**[www.myrabbitflex.com](http://www.myrabbitflex.com)**



For a limited time with kit purchase.



2900 Spafford Street, Davis, CA 95616 Tel **530.757.8400**  
**Solutions That Work**



# NUTS AND VOLTS

JANUARY 2007



## PROJECTS and FEATURES

### 34 CONTROL YOUR WORLD

Part 4: Build a gaming exercise bicycle.

■ By Michael Simpson

### 40 CHARGE ALL BATTERY CHARGER SWITCHER

Keep all your batteries charged and ready for action.

■ By Kenton Chun

### 46 BUILD A RING FLASH FOR MACRO PHOTOGRAPHY

Get the smallest of details in your photos with this "flashy" device.

■ By Fernando Garcia

### 54 GETTING STARTED WITH PICAXE MICROCONTROLLERS

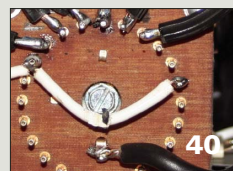
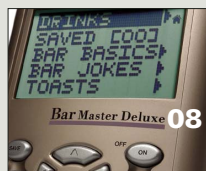
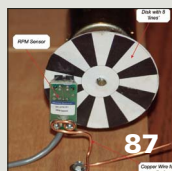
Part 1: Are you new to the world of programmable microcontrollers and looking for an inexpensive place to start?

■ By Ron Hackett

### 60 INTERFACING STANDARDS: RS-232

There are various common interfaces available and choosing the best one is not always trivial.

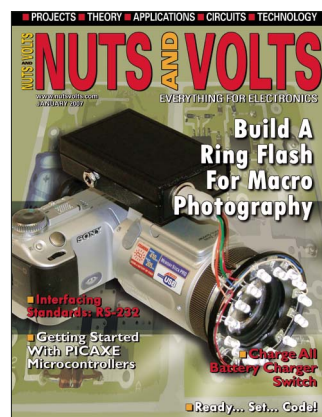
■ By Gerard Fonte



## ON THE COVER ...

### Build a Ring Flash for Macro Photography

Page 46



## COLUMNS

### 08 TECHKNOWLEDGEY 2006

Events, advances, and news from the electronics world.

### 12 STAMP APPLICATIONS

Ready ... Set ... Code!

### 18 Q&A

Bypass caps demystified, "B" battery eliminator, power supply ripple meter, plus more.

### 72 NEAR SPACE

BalloonSats, PongSats, and the Idaho Cluster Bomb.

### 80 THE DESIGN CYCLE

Core Networking Development: Zigbee.

### 87 PERSONAL ROBOTICS

Motor Test Lab — Part 1.

### 94 GETTING STARTED WITH PICs

PIC12F675 Replaces the 555Timer.

## DEPARTMENTS

### 06 READER FEEDBACK

### 28 NEW PRODUCTS

### 32 SHOWCASE

### 33 NEWS BYTES

### 67 ELECTRO-NET

### 98 CLASSIFIEDS

### 100 NV BOOKSTORE

### 102 TECH FORUM

### 105 ADVERTISERS INDEX

Nuts & Volts (ISSN 1528-9885/CDN Pub Agree#40702530) is published monthly for \$24.95 per year by T & L Publications, Inc., 430 Princland Court, Corona, CA 92879. PERIODICALS POSTAGE PAID AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: Send address changes to **Nuts & Volts, P.O. Box 15277, North Hollywood, CA 91615** or Station A, P.O. Box 54, Windsor ON N9A 6J5; [cpcreturns@nutsvolts.com](mailto:cpcreturns@nutsvolts.com)





# Link Instruments

PC-Based Test Equipment

## Digital Oscilloscopes

**NEW!**



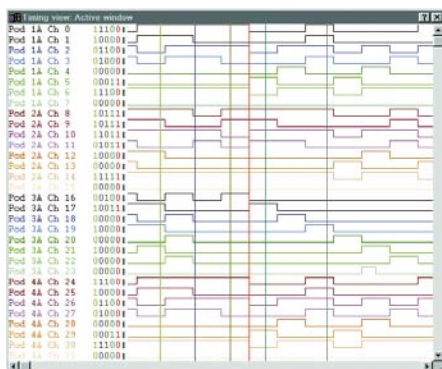
- 2 Channel Digital Oscilloscope
- **500 MSa/s** max single shot rate
- 1Mpt sample memory
  - 250 MSa/S (Dual channel) 512 Kpts
  - 500 MSa/S (Single channel) 1 Mpts
- Advanced Triggering
- Only 9 oz and 7" x 3.5" x 1.5"
- Portable and Battery powered
- USB 2.0
- Advanced Math
- FFT Spectrum Analyzer
- Priced at only **\$950**

**500MSa/s**

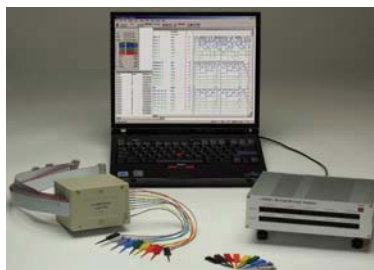


**1Mpts**

## Logic Analyzers



Windows Screenshot



- 40 to 160 channels
- up to 500 MSa/s
- Variable Threshold
- 8 External Clocks
- 16 Level Triggering
- up to 512K samples/ch
- USB 2.0 and Parallel Interface
- Pattern Generator option

|                         |               |
|-------------------------|---------------|
| LA5240 (200MHz, 40CH)   | <b>\$1700</b> |
| LA5280 (200MHz, 80CH)   | <b>\$2350</b> |
| LA5540 (500MHz, 40CH)   | <b>\$2500</b> |
| LA5580 (500MHz, 80CH)   | <b>\$3500</b> |
| LA55160 (500MHz, 160CH) | <b>\$7500</b> |



Link Instruments (973) 808-8990

17A Daniel Road East · Fairfield, NJ 07004 · Fax (973) 808-8786

**www.Link-instruments.com**



## BREAKING THE CODE

In the article "Furnace Backup" December 2006, the author states that "Most furnaces require dedicated electrical branch circuits by code." He then goes on to show your readers how to circumvent the National Electric Code and wire their home furnace in violation of the code. If a reader does this, and has a house fire, their insurance company may not pay for the fire damages. I hope your readers do not do this.

There is a way to connect a secondary power source to your furnace. First, install a UL approved generator transfer switch to your breaker panel. This switch is designed to keep all branch circuits connected to power

ground and power common (white wire). Only the hot lead (black wire) is switched from the utility power to the secondary power source. The National Electric Code allows you a fair amount of design flexibility with your secondary power source (ex: generator or UPS) as the current they provide is limited. Secondly, a UPS can be the secondary power source. The ground wire (green) and common wire (white) are still connected at the breaker panel. The correct kind of UPS can then be plugged into the generator transfer switch instead of a generator as a secondary power source.

There is still one more big problem to overcome when connecting a UPS to your house: Make sure you know if the UPS can have its charging circuit tied to the same power common as one of its output leads. It may short out. Most UPSs need to float both output wires.

**Vincent  
Saladino,  
PE**

*Writer Response:  
Thanks for  
your feedback!*

*It is not out  
of code to place  
any appliance on  
a UL approved  
UPS provided it is  
isolated in its own  
dedicated circuit.*

*There is no  
possible way to  
backfeed the utility  
or significantly  
increase the risk  
of fire by doing  
this. It is no different  
than putting your television  
set on a UPS.*

*Yes, it is true  
that insurance  
companies will  
look for any  
reason not to pay  
claims. Any elec-*

Reliable **ZigBee™**  
Mesh Networks

**ZigBee™**  
certified

- Easy-to-use
- Up to eight times the range of typical ZigBee
- Order a development kit today!

|           | Frequency | Indoor Range | Outdoor Range | Power Output | Mesh Network | Agency Approvals |
|-----------|-----------|--------------|---------------|--------------|--------------|------------------|
| XBee™     | 2.4 GHz   | 30 m         | 100 m         | 1 mW         | Yes          | Global           |
| XBee-PRO™ | 2.4 GHz   | 100 m        | 1.6 km        | 60 mW        | Yes          | Global           |

**MaxStream®** [www.maxstream.net](http://www.maxstream.net) 866-765-9885

Published Monthly By  
**T & L Publications, Inc.**  
430 Princeland Ct.  
Corona, CA 92879-1300  
(951) 371-8497  
FAX (951) 371-3052  
Product Order Line 1-800-783-4624  
[www.nutsvolts.com](http://www.nutsvolts.com)

**Subscriptions**  
Inside US 1-877-525-2539  
Outside US 1-818-487-4545  
P.O. Box 15277  
North Hollywood, CA 91615

**FOUNDER/ASSOCIATE PUBLISHER**  
Jack Lemieux

**PUBLISHER**  
Larry Lemieux  
[publisher@nutsvolts.com](mailto:publisher@nutsvolts.com)

**ASSOCIATE PUBLISHER/  
VP OF SALES/MARKETING**  
Robin Lemieux  
[display@nutsvolts.com](mailto:display@nutsvolts.com)

**CONTRIBUTING EDITORS**  
Chuck Hellebuyck TJ Byers  
Jeff Eckert Jon Williams  
Peter Best Phil Davis  
Kenton Chun Ron Hackett  
Gerard Fonte Fernando Garcia  
Michael Simpson Paul Verhage

**CIRCULATION DIRECTOR**  
Tracy Kerley  
[subscribe@nutsvolts.com](mailto:subscribe@nutsvolts.com)

**SHOW COORDINATOR**  
Audrey Lemieux

**WEB CONTENT/NV STORE**  
Michael Kaudze  
[sales@nutsvolts.com](mailto:sales@nutsvolts.com)

**PRODUCTION/GRAPHICS**  
Shannon Lemieux

**ADMINISTRATIVE ASSISTANT**  
Debbie Stauffacher

Copyright © 2007 by T & L Publications, Inc.  
All Rights Reserved

All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints, or typographical errors. *Nuts & Volts Magazine* assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in *Nuts & Volts*. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action, or expense arising from advertising placed in *Nuts & Volts*. Please send all editorial correspondence, UPS, overnight mail, and artwork to: 430 Princeland Court, Corona, CA 92879.



# Ultra-Low Power. Ultra-Cool Designs.

Hundreds of engineers from more than 100 countries entered TI's MSP430 eZ Design Contest. Check out the winning designs at [www.ti.com/designmsp430](http://www.ti.com/designmsp430) and see how they took advantage of the MSP430's ultra-low-power technology and high integration. Plus be sure to visit the MSP430 VirtualLab at [www.ti.com/designmsp430](http://www.ti.com/designmsp430), where we make it free and easy for you to experiment with the world's lowest power microcontroller and develop your own winning designs. And don't forget to check out the **new eZ430 compatible MSP430T2012 target board**.



**NEW!**

**MSP430T2012 Target Board  
3-Pack for \$10**

## T2012: Easy to Use

- Compatible with eZ430-F2013
- All F20xx devices pin compatible
- 10-bit, 200-kps ADC
- Great way to start using the MSP430

## T2012: Easy to Order

- Three T2012 target boards for only \$10
- [www.ti.com/t2012](http://www.ti.com/t2012)
- Designing with the lowest-power MCU just got easier!

| Name                   | Contents Includes              | Devices Supported | Price         |
|------------------------|--------------------------------|-------------------|---------------|
| eZ430-F2013            | USB interface and target board | MSP430F20xx       | \$20          |
| <b>NEW</b> eZ430-T2012 | eZ430 Target Board             | MSP430F2012       | \$10 / 3-pack |

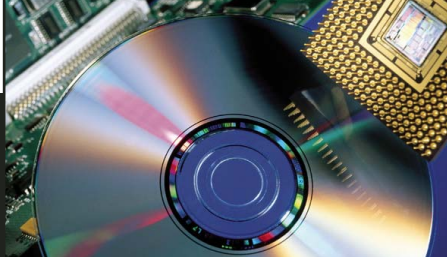
Technology for Innovators and the red/black banner are trademarks of Texas Instruments.

Technology for Innovators™

August 2006 NUTS!VOLTS 7  
**TEXAS INSTRUMENTS**

© 2006 TI





■ BY JEFF ECKERT

## ADVANCED TECHNOLOGY

### LASER DEFENSE PASSES GROUND TESTS

PHOTO COURTESY OF BOEING.



■ Artist's concept of the ABL destroying Scud-type missiles in launch phase.

If you have been wondering what happened to the concept of a laser defense system, be advised that the Air Force's Airborne Laser (ABL) program (affectionately referred to as "reach out and fry someone") is still under development by Boeing, TRW, Northrop Grumman, and Lockheed Martin. At its Wichita facility, Boeing ([www.boeing.com](http://www.boeing.com)) recently conducted ground tests of the modified 747-400F freighter that will carry a high-energy laser to provide early interception of unfriendly missiles. Details are scarce, but the device is described as a "megawatt chemical oxygen iodine laser" operating at a wavelength of 1.315 microns.

Although the tests employed a surrogate laser rather than the real thing, the aircraft was fitted with the actual Lockheed Martin beam control/fire control system, which includes two solid-state illuminator lasers: one to track the target and the other to measure atmospheric turbulence between the high-energy laser and the target. During the tests, results from the illuminator firings were fed back to ABL, allowing the surrogate high-energy laser to shoot down a simulated target.

According to Boeing, the program achieved most of its objectives and is

expected to satisfy the remaining ones in coming months. The next step will be to fire the illuminators in flight at a missile-shaped image painted on a test aircraft as a test of the ABL's tracking and atmospheric compensation capabilities. The complete system — operating from a nose-mounted turret — will be able to destroy all classes of ballistic missiles in their boost phase of flight.

Also under development is the Advanced Tactical Laser (ATL) system, which employs a belly-mounted turret in a C-130H gunship to destroy, damage, or disable targets with little to no collateral damage, supporting missions on the battlefield and in urban operations. ATL will produce scalable effects, meaning that the operator will be able to select the degree and nature of the damage done to a target by choosing a specific aim point and laser shot duration. For example, hitting the fuel tank of a vehicle could result in its total destruction, whereas targeting a tire might simply stop the vehicle without injuring the driver. Apparently, the age of directed-energy weapons is upon us.

### AUDIO TELESCOPE TO PROTECT AIRCRAFT

On a somewhat less dramatic scale, researchers at the National Institute of Standards and Technology (NIST, [www.nist.gov](http://www.nist.gov)), Intelligent Automation, Inc. ([www.i-a-i.com](http://www.i-a-i.com)), and the University of Missouri-Columbia ([www.missouri.edu](http://www.missouri.edu)) have modified an NIST-designed microphone array so that it may be used to help pilots

avoid collisions with birds. In the US alone, such clashes have actually caused more than \$2 billion worth of damage, destroyed 163 aircraft, and killed 194 people over the last couple decades, so this is not a trivial matter.

The audio telescope, still in the prototype stage, is based on NIST's Mark-III microphone array, which is a high-performance directional audio signal processing system designed for speech-recognition computing systems in complex sound environments. The bird version will be a 1 m dia. concentric array of 192 mikes mounted parallel to the ground and aimed upward. By comparing the arrival time of sounds at different microphones, the array can get a directional fix on the sound and even pick up simultaneous sounds coming from different directions.

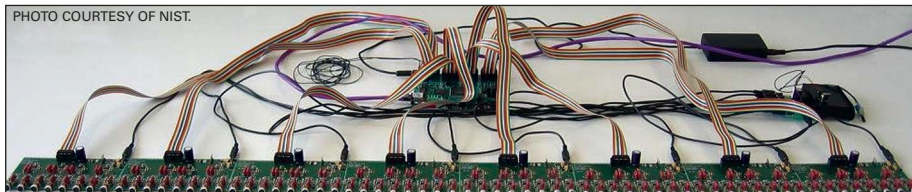
Using mathematical algorithms designed to allow speech recognition systems to identify different speakers, the system can even distinguish between bird species by their calls. For example, it can tell a Canada goose from a gull or a hawk. Because different species pose different risks, this can be a useful feature. The device should provide better performance than existing X-band radars and infrared cameras, which cannot make such distinctions and also are degraded by bad weather.

## COMPUTERS AND NETWORKING

### WIDESCREEN DISPLAYS INTRODUCED

■ The garden variety Mark-III array.

PHOTO COURTESY OF NIST.



Consistent with the trend towards bigger and more elaborate LCD displays for less money are two new models from Gateway ([www.gateway.com](http://www.gateway.com)): the 24 inch FPD2485W (1920 x 1200 resolution) and the 22 inch FPD2285W (1680 x 1050). Both models are “universal,” meaning that they feature multiple analog and digital video inputs to provide connectivity for a wide range of PCs and other consumer electronic devices, and they employ Faroudja directional correlation deinterlacing (DCDi) to avoid jaggies caused by interpolation ([www.meridian-audio.com/faroudja](http://www.meridian-audio.com/faroudja).)

You also get the new EzTouch™ touch-sensitive control system, auto-rotation capabilities, and a high-fidelity speaker option (for the 24 inch one only; \$69.99 extra). Both displays offer picture-in-picture (PIP) functionality, allowing users to work on computer applications while simultaneously viewing programming from cable, satellite, or other video sources. The list prices are \$679.99 and \$399.99, but they have been seen lurking on the Internet for a little less.

## FREE ACCOUNTING SOFTWARE

Other than the usual flow of patches and bug fixes, you don't often get useful software for free. However, a couple months ago, Microsoft ([www.microsoft.com](http://www.microsoft.com)) announced the availability of Office Accounting Express 2007, a financial management package designed for early startups and home-based businesses that currently use pen and calculator or spreadsheets to run their operations. The package consists of desktop software available as a free download plus seven integrated online services. Features include: (1) online service integration with eBay, PayPal® and Equifax®; (2) the ability to create quotes, invoices, and receipts, as well



as write checks, track expenses, and reconcile online bank accounts; (3) track employee time and manage payroll and taxes through integrated services from ADP®; and (4) centralize customer information and simplify sales and marketing through integration with Microsoft Office Outlook® 2007.

The company isn't being entirely magnanimous, however, because it also offers premium online services that involve additional fees. Plus, it hopes to lure you into the \$149 upgrade to Microsoft Office Accounting Professional. But initial reviews of the freeware version have been positive. To download it, just visit [www.ideawins.com](http://www.ideawins.com). Note that you need to be running Windows® XP, 2003 Server, or Vista.

## SPAM CHAMPIONS ANNOUNCED

The IT security company Sophos Plc. ([www.sophos.com](http://www.sophos.com)) recently announced that we have met the enemy, and he is us. Topping the latest “Dirty Dozen” list of spam-producing countries is the good old USA, from which emanates 21.6% of the world's supply. In second place, with 13.4% is China (including Hong Kong), followed by France and South Korea, with 6.3% each. However, we don't necessarily need to feel all that guilty about it. According to a senior security consultant at Sophos, “Most unsolicited emails are now sent from zombie PCs — computers infected with Trojans, worms, and viruses that turn them into spam-spewing bots.

In the past, hackers were very reliant on operating system vulnerabilities to convert an innocent computer into a zombie. Now they are turning back to malware to trick users into running their malicious code, and opening the back door to hackers ... Hundreds of new versions of the Stratio worm have helped steadily increase the volume of spam seen travelling across the net.”

It was reported elsewhere ([www.message-labs.com](http://www.message-labs.com)) that spam constituted 72.9% of worldwide email in October (an increase of 8.5% over September); one in every 100.3 emails contained a virus, and one in 190 were phishing attacks. It's still a jungle out there.

## CIRCUITS AND DEVICES

### GADGET OF THE MONTH

Apologies for running across this one too late for the holidays, but if you're stumped for a great birthday or other present, consider



■ The Bar Master Deluxe from Excalibur Electronics ([www.excalibur-electronics.net](http://www.excalibur-electronics.net)). Yes, it can provide you with recipes for more than 1,000 of the most popular mixed drinks, but it also provides images of the proper glass to use, sound effects (clinking ice, blender whirring), bar jokes, toasts, blood alcohol level calculations, and other bar-related information. Not bad for \$29.95. For \$49.95, the company also offers a radio-controlled drink float that delivers up to five drinks and a bowl of chips to people who are lounging around in your pool.

### SMALL FAN, LARGE FLOW

If you find yourself in need of a very small source of cooling air, check out the Super-Flow Micro series of high-flowing micro-sized fans from Jaro Thermal ([www.jarothermal.com](http://www.jarothermal.com)). Designed primarily for PDA, cell phone, and other limited-space applications, the fans measure only 15 x 15 x 6 mm and weigh 1.4 g but, spinning at up to 15,000 rpm, move 0.22 cfm. Designed for a 50,000-hour operating life, you get a choice of 5V or 12V models. The price is \$5.25 each in manufacturing quantities.



# INDUSTRY AND THE PROFESSION

## NANOTECH COMPETITION SCHEDULED

If you are involved in nanotechnology, either professionally or as a student, note that a nanotechnology-oriented forum, bringing together academia, industry, and budding entrepreneurs, will be held April 2-4, 2007, at Oak Ridge National Laboratory ([www.ornl.gov](http://www.ornl.gov)). Nano Nexus 2007 is designed to foster innovation and increase collaboration between universities, government, industry, and the investment community and will also serve as a component of the Innovation Valley Nano Initiative, an effort to cultivate nanotechnology business in the region. It will feature three main events: (1) Idea to Product® or I2P®, a nanotechnology business competition for university graduate students that involves a \$25,000 prize; (2) Nano Industry Forum, where representatives from top corporations will present their toughest research problems and connect with researchers who

can help them out; and (3) Nano Venture Showcase, a venture capital forum showcasing the most promising nanotechnology start-up companies. Participating partners include the University of Tennessee, Duke University, Florida State University, Georgia Institute of Technology, and Vanderbilt University. For details, see [www.nanonexus.org](http://www.nanonexus.org).

## BATTERY STANDARDS REVISED

In the wake of Sony recalling (as of this writing) some eight million laptop batteries, the Institute of Electrical and Electronics Engineers (IEEE, [www.ieee.org](http://www.ieee.org)) will be revising its related standard, IEEE 1625?, "IEEE Standard for Rechargeable Batteries for Portable Computing," which was approved in 2004. This update "targets an improvement in the overall performance of laptop battery systems and seeks to address recent calls to make these systems more reliable and robust." The project, which is expected to include participation by Apple, Dell, Gateway, Hewlett-Packard, IBM, Intel, Lenovo, Panasonic, Sanyo, and Sony, is set for completion in 18 months.

## POSSIBLE DVD SOLUTION

As you probably are aware, there is a war in the next-generation DVD market between manufacturers who

favor the Blue-ray format (Sony and friends) and those who back HD DVD (Toshiba et al.). Consumers, as usual, are caught in the middle, which brings back tortured memories of the VHS

vs. Betamax battle. But riding in on a white horse (or possibly a white elephant) is Broadcom Corp. ([www.broadcom.com](http://www.broadcom.com)), which has developed a system-on-a-chip (SoC) solution that combines both formats.

The recently-announced BCM7440 Blu-ray/HD DVD SoC offers OEMs a single-chip media player design that integrates a multiple-core MIPS® architecture, a multi-stream HD video decoder, dedicated graphics engines, DSP-based audio processors, a security processor, DDR2 interfaces, integrated video and audio outputs, and an array of system and network connectivity interfaces.

It incorporates the decoding, processing, and memory functions for both Blue-ray and HD DVD media players, eliminating the need for manufacturers to build two different hardware platforms. The chip supports audio and video compression standards required for both formats, including H.264/AVC, VC-1, MPEG-2, Dolby® Digital Plus, Dolby Tru-HD, and DTS-HD.

The BCM7440 also provides full backward compatibility for current DVD video titles as well as DVD-R, DVD-VR, and audio CDs. The chip is currently available in sample volumes as a 761-ball BGA. Pricing is available on request. **NV**

**WWW.POWERWERX.COM**  
**POWER CONNECTOR SUPERSTORE**  
**Standardize Your Power Connectors**

**Best choice for New Hams**  
Share Emergency Power • Reusable • Easy to Use  
Anderson Powerpoles®, Adapters & Accessories

VeriSign  
Easy secure  
online ordering

Authorized **RIGblaster** & **RIGrunner** Dealer

**powerwerx.com**

Huge savings • lowest prices  
Over 1500 products in stock • Satisfaction guaranteed!





# Ring In the New Year With New Equipment From PolarisUSA Video!

[www.polarisusa.com](http://www.polarisusa.com)



**TFT-35CC**  
**\$189.95**

- 3.5" TFT LCD Monitor
  - Charger & Carrying Case Included
  - Great for Camera Setup and Installation
- New Product!**

*Great for Camera  
Setup & Installation*



**SYS-04**  
**\$1199.98**

*Complete Indoor 4 Color Day/Night  
Dome Camera System with 15" Monitor,  
Network & CD-RW Enabled 120GB Digital Video Recorder*

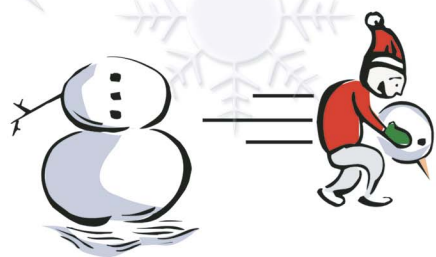
**24**  
*Years of Service!*



**SCAN-24GHZ**  
**\$439.95**

- Complete Handheld Wireless  
Camera Scanner with 2.5" TFT Monitor Kit*
- Hunts Down and Finds Any Wireless Camera!
  - From 900 MHz thru 2.4GHz
- New Product**

**Don't Let Hooligans Ruin Your Holidays!**



**VR-2400**  
**\$99.95**

*2.4GHz Wireless  
Audio/Video Receiver*

**WCC-2400**  
**\$69.95**

*2.4 GHz Wireless  
Color Camera*



**SYS-08**  
**\$899.95**

- Complete Indoor/Outdoor Day/Night Lipstick Color Four Camera System*
- Ganz 15" COLOR Monitor - 450 TV Lines - Audio - 2 Video
  - Affordable 4-Channel Stand-Alone DVR w/ 120GB HDD

**PDVR-24SD**  
**\$399.95**

*Micro SD-Card MPEG-4 Recorder  
with built in 2.4 TFT LCD*

**New Product!**



**Toll Free**  
**800-308-6456**

**PolarisUSA Video**

**Local**  
**678-405-0089**

*Prices Subject  
to Change  
Without Notice*

**Video Security From The Professionals at PolarisUSA**

*Actual Images  
May Vary*

PolarisUSA Video, Inc. · 3158 Process Drive · Norcross, GA · 30071



■ BY JON WILLIAMS

## READY ... SET ... CODE!

**HAVING BEEN A PART OF THE BASIC STAMP COMMUNITY** since 1994, I've had the wonderfully-good fortune to meet a lot of experimenters, and — due to my exposure through *Nuts & Volts* and six years with Parallax — I've been asked to create a wide variety of projects. One of the most frequently requested, but that is not really practical with a BASIC Stamp, is a Pinewood Derby racing timer. Well, now that programming the SX is nearly as easy as programming the BASIC Stamp, the race timer can finally be realized — and even provide one-millisecond resolution using nothing but Basic.

If you've read my past articles on SX/B, you may remember that I've always taken a bit of a cautionary position when it comes to using interrupts. We must always keep in mind that interrupts steal time from the foreground program, and we must be particularly mindful when using time-sensitive instructions like **PAUSE**, **SEROUT**, etc. That said, there are times when using interrupt-driven code is actually the better choice over linear programming. Our race timer is one of those kinds of projects; especially since we want to create a timer with a one-millisecond resolution while multiplexing a multi-digit LED display.

For a compiler that's absolutely free, SX/B does a fantastic job with interrupts — better than most Basic compilers that cost hundreds of dollars.

Still, interrupts should be approached carefully. With a bit of thought and planning, we can have interrupts without headaches running on the SX in SX/B. In fact, we'll see that with the improvements since SX/B 1.51, this project becomes nearly trivial.

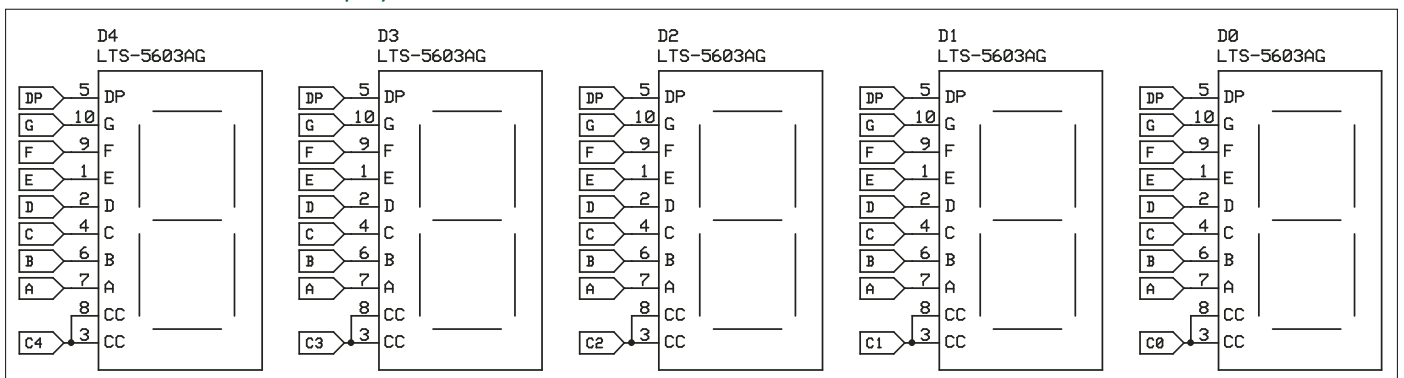
First thing's first: What does the race timer need to do? For starters (no pun intended), the timer should accept a remote start signal so that it can be used in single- or multi-track setups. We'll also need a remote clear signal so that we can reset the time to zero before a race. When running, we need to keep track of the time and, most importantly, display it on a five-digit, seven-segment display.

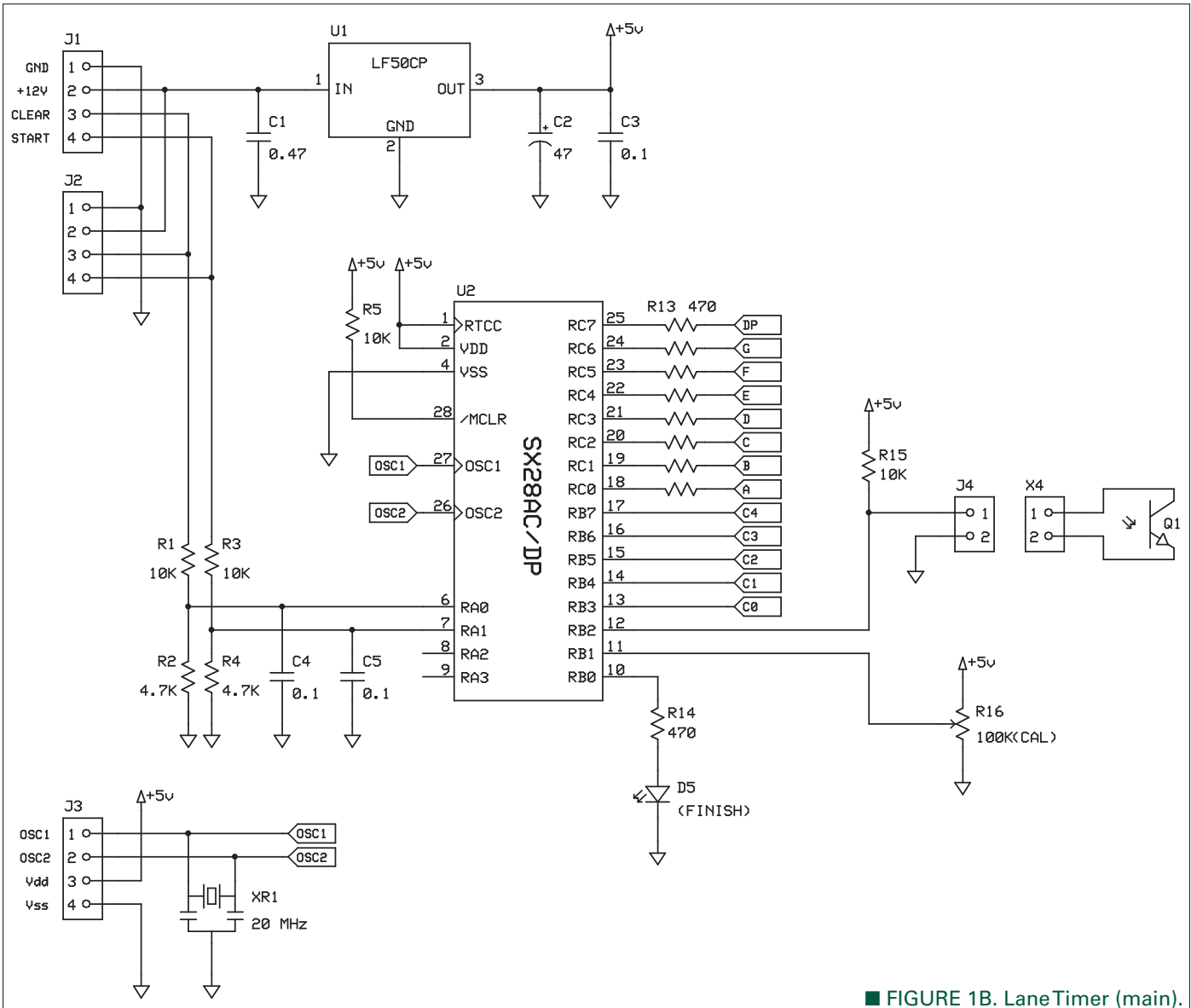
Figure 1 (A and B) shows the schematic for the timer using an SX28. Much of the I/O is devoted to the seven-segment displays, with a few bits

to monitor the finish line photo-transistor and Clear and Start inputs. Note that power and control inputs come in and go back out on four-pin connectors. The idea is that this will make construction of multi-track setups simpler. Since the power connection provides 12 volts, the Clear and Start signals are also 12 volts. A two-resistor divider brings the signal voltage down to about 3.8 volts; this is well above the TTL switching threshold of 1.4 volts for the SX. Note, too, that we're using the SX comparator input to detect finish. By using the comparator, we can adjust the input set-point (with R16) and accommodate a wide variety of ambient lighting conditions.

From the firmware standpoint, the two most critical elements of the program are the event timing and display multiplexing — this is where an

■ FIGURE 1A. LaneTimer (display).





■ FIGURE 1B. LaneTimer (main).

interrupt will come in handy. How about if we interrupt the program every millisecond to update the timer and the display — that's easy, right? Yes, it absolutely is.

Periodic interrupts in the SX are controlled by the OPTION register, and when using assembly or SX/B versions prior to 1.51, we would have to set this register manually. This is not a huge hassle, but if we decided to change the clock frequency or interrupt rate, we'd have to do it again. Well, not any more. Since we want to interrupt the program every millisecond — or 1,000 times per second — we simply tell the SX/B compiler that's what we want to do:

```
INTERRUPT 1000
```

Yes, that's it. As of SX/B version 1.51, the compiler will calculate the proper value for the OPTION register and will put it into the startup section. If you want to see this, press Ctrl-L to see the list file, and then scroll down to the label RESET \_\_PROGSTART; at the end of this section you'll see

the OPTION register setting. If you change the FREQ value or interrupt rate, you can check back to see that the OPTION register value has, in fact, changed.

Okay, now let's write the code that runs in the interrupt. Before we do that, though, I want to remind you that in SX/B we must define subroutines and functions before they're called. This creates a bit of a problem if we want to call a subroutine from the interrupt section as the interrupt entry must be the first thing in the program. The solution is actually quite simple: we move the actual code to another location that comes after the subroutine and function declarations. Getting to it is as simple as **GOTO**. So, the interrupt section of the program ultimately looks like this:

```
INTERRUPT 1000
GOTO INT_HANDLER
```

Now it's just a matter of putting the code that runs in the interrupt at a label called INT\_HANDLER. In case you're wondering, this section does need to use **RETURNINT**



instead of **RETURN**; this is necessary to make sure the RTCC value is reloaded properly and interrupts re-enabled. Let's have a look at the interrupt handler:

```
INT_HANDLER:
  IF ops <> M_RUN THEN Next_Digit

Update_Clock:
  INC ms
  IF ms = 10 THEN
    ms = 0
    INC hs
  IF hs = 10 THEN
    hs = 0
    INC ts
  IF ts = 10 THEN
    ts = 0
    INC sec01
  IF sec01 = 10 THEN
    sec01 = 0
    INC sec10
  IF sec10 = 6 THEN
    ops = M_STOP
  ENDIF
ENDIF
ENDIF
ENDIF

Next_Digit:
  INC digPtrn
  IF digPtrn = NumDigits THEN
    digPtrn = 0
  ENDIF

Update_Segs:
  Segments = %00000000
  READ Dig_Map + digPtrn, DigCtrl
  Segments = display(digPtrn)

Check_Finish:
  IF AtFinish = Yes THEN
    ops = M_STOP
  ENDIF

RETURNINT
```

Yes, it looks a little long, but as you'll soon see, this section of code does most of the work for the race timer. In practice, the timer has three modes: 0) stopped and clear, 1) running, and 2) stopped. The current mode is held in the variable called *ops* (*mode* and *status* are SX keywords, so they can't be used). If the timer is not supposed to be running then we skip past its update and move to the next digit of the multiplexed display.

The display update routine points to the next digit (right to left) and then checks if we need to wrap back to digit zero. Then the segments (anodes) are cleared before reading the current digit pattern from the *display* array. Clearing the segments before writing a new value to them creates a crisper display to my eye, but you may want to experiment with this. The cathode control value for the current digit is read from a **DATA** table. While we could have generated the proper active-low cathode control value with code, using a table approach just seemed more elegant.

With the display updated, the last thing the interrupt section does is check to see if the finish-line opto-transistor is blocked. If it is, the mode will be set to *M\_STOP* and if the

clock was running it will halt at that point, allowing us to view the duration of the race until the Clear button is pressed.

Let's back up — we haven't talked about updating the clock when it's supposed to be running. I used to work for a guy who told me that there are no compromises in product development, but there are choices to be made. Case in point: We could store the timer milliseconds as a word and the timer seconds as a byte, but then we'd have to use division to extract the individual digit values for each position and, as you know, division can be computationally heavy. So, I chose to use discrete variables for each clock digit; this means using five bytes for the timer instead of three, but I think the benefits far outweigh the use of two additional byte variables. By using this approach, we're able to update the display segments much more easily (we'll see that in just a bit) and if we chose to modify the program to send the digits out serially to a terminal, we'd already have the individual digit values in place — again, no division required.

Updating the clock in the interrupt handler is easy; we start with the milliseconds digit, *ms*. It gets incremented and when it reaches 10, we reset it to zero and increment the hundredths digit, *hs*. You can see that this process ripples through each of the five variables, the difference being that we don't clear the tens digit when it reaches its limit, we simply stop the clock at one minute (60 seconds). The choice of using individual variables to the timer digits does make the code a little longer in this section, but if you look at the assembly output, you'll see that there is nearly a 1-for-1 ratio of SX/B to assembly so the clock update process is happening pretty quickly.

Now that we have a timer that can update and display its value, we need to build the control code for starting, stopping, and clearing it, and we'll also need a routine to convert the timer digit values to segment patterns for the LED display. Let's get the program started:

```
Start:
  TRIS_B = %00000111
  PLP_A = %00000011

  COMPARE 1, __PARAM1
```

There's just a couple things going on here — we set the cathode control pins to outputs and pull-up the unused pins on RA. Next, we start the comparator in mode 1. This mode activates the comparator with the result bit output on RB.0. An interesting note here is that we do not need to make RB.0 an output for this pin to operate the LED connected to it; the comparator output bit is connected directly to the pin. The program will monitor the state of RB.0 to determine if the opto-transistor is blocked; when it is, the clock will be stopped.

Note, too, that we don't care about the initial output of the **COMPARE** instruction so we can use one of the internal variables to receive the result. Since the comparator will continue to run and put its result on RB.0 until disabled, we only need to run this instruction one time.

Finally, some may be wondering why we didn't set the *TRIS\_C* register for the segment pins (RC). Well, the **PIN** definition takes care of that for us when we use the optional **OUTPUT** directive like this:

| Segments | PIN | RC | OUTPUT |
|----------|-----|----|--------|
|----------|-----|----|--------|

We couldn't do this on RB because we have a mixed I/O structure. And now we get to the main program loop — which really doesn't have a lot to do.

```

Main:
DO
  UPDATE_DISPLAY
  IF Go = Yes THEN
    IF ops = M_CLEAR THEN
      ops = M_RUN
    ENDIF
  ENDIF
  IF Clear = Yes THEN
    IF ops = M_STOP THEN
      PUT @ms, 0, 0, 0, 0, 0
      ops = M_CLEAR
    ENDIF
  ENDIF
LOOP

```

The first thing that happens is call UPDATE\_DISPLAY converts the timer digit values to segment patterns for the LEDs. Even though we only call this once, I still think it's a good idea to encapsulate it into a subroutine so that the program can be somewhat modular. Let's have a look at UPDATE\_DISPLAY.

```

UPDATE_DISPLAY:
  READ Seg_Map + ms, display(0)
  READ Seg_Map + hs, display(1)
  READ Seg_Map + ts, display(2)
  READ DP_Map + sec01, display(3)
  IF sec10 = 0 THEN
    display(4) = Blank
  ELSE
    READ Seg_Map + sec10, display(4)
  ENDIF
  RETURN

```

As you can see, this is actually quite simple. **READ** is used to transfer segment maps from a **DATA** table into each element of the display array. Since we know where the decimal point is going to be, simply hard code that into the program, in this case it will follow the ones digit, and we'll use a separate table with digit patterns plus a decimal point — this saves us the step of adding the decimal point a bit later. If you decide to modify the timer to have a variable-position decimal point, you could always do something like this:

```

UPDATE_DISPLAY:
  IF DP_Digit = 0 THEN
    READ DP_Map + ms, display(0)
  ELSE
    READ Seg_Map + ms, display(0)
  ENDIF
  . . .

```

The one slightly-fancy thing we'll do here is blank the leading zero in the tens digit position; it just makes the output more professional looking in my opinion. From a code standpoint, it's a simple matter of clearing the segments when the tens digit is zero, or reading the new segment pattern when it isn't.

To get the timer started, it needs to be in mode zero (defined as M\_CLEAR). When we get a high input on RA.1 when in this mode the timer is started by updating the ops

variable to M\_RUN (1). Remember, the interrupt is always running (1,000 times each second) so as soon as we update ops, the display will start changing. Once the car crosses over the finish line and blocks the opto-transistor (which causes the comparator output to go high), the timer will be stopped by changing its mode to M\_STOP (2). In this mode, we can monitor the Clear input on RA.0 to reset everything.

One of the little-used yet convenient keywords in SX/B is **PUT**. This command takes a RAM address and a list of one or more values. The first value is written to the address. If there are more values, the address is incremented and subsequent values written. This makes it really easy to move a set of values into a section of contiguous RAM that is not part of an array.

Note that we used the @ (address of) indicator with the ms variable after **PUT**. We have to do this because **PUT** is expecting an address as the first parameter. If, however, we use **PUT** with an array, we don't need the @ indicator. The reason for this is that arrays are always treated [internally] as address pointers and offsets.

## PUTTING IT TOGETHER

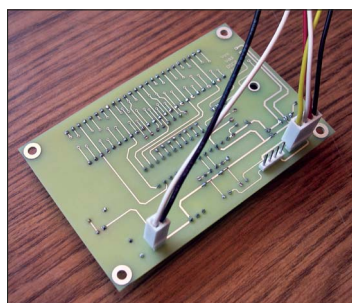
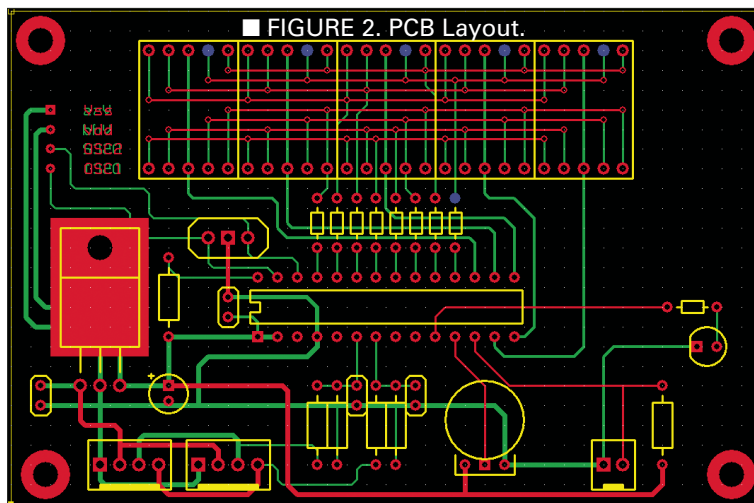
Last month, I used point-to-point wiring on the Menorah board because most of the hard work was done by Parallax with the Super Carrier. And while this project *could* be wired point-to-point, I certainly don't have the patience to do it. Enter ExpressPCB. Since I don't create a lot of printed circuit boards, I find the ease-of-use and ordering via **ExpressPCB.com** to be right up my alley. I particularly like that the companion program — ExpressSCH (schematic capture) — can be linked to the board file to assist in making connections — this was especially useful for the seven-segment displays.

I'll never be accused of being a PCB layout expert, so I'm not going to spend a great deal of time here. What I want to share with you was my solution for dealing with the displays. I started by selecting display modules that have rows of horizontal pins. Once I had created a custom component in ExpressPCB and dropped five of them onto the board, I found the easiest way to tie all of the segment signals together was to lay down a horizontal buss of eight lines on the top side (red)

## ◆ PINWOOD DERBY TIMER BILL OF MATERIALS

| Designator        | Value             | Source                   |
|-------------------|-------------------|--------------------------|
| ► C1              | 0.47 µF           | Mouser 80-C320C474M5U    |
| ► C2              | 47 µF             | Mouser 647-UVR1C470MDD   |
| ► C3-C5           | 0.1 µF            | Mouser 80-C315C104M5U5TA |
| ► D0-D4           | Seven-segment, CC | Mouser 859-LTS-5603AG    |
| ► D5              | Red LED           | Mouser 638-204HT         |
| ► J1, J2          |                   | Mouser 571-6404544       |
| ► J4              |                   | Mouser 571-6404542       |
| ► Q1              | IR Detector       | RadioShack 276-142       |
| ► R1, R3, R5, R14 | 10K               | Mouser 291-10K-RC        |
| ► R2, R4          | 4.7K              | Mouser 291-4.7K-RC       |
| ► R6-R14          | 470Ω              | Mouser 299-470-RC        |
| ► R16             | 100K              | Mouser 652-3352T-1-104LF |
| ► U1              | 5V, LDO           | Mouser 511-LF50CP        |
| ► U2              | SX28AC/DP         | Parallax SX28AC/DP-G     |
| ► X4              |                   | Mouser 538-22-01-2027    |
| ► XR1             | 20 MHz            | Parallax 250-02060       |

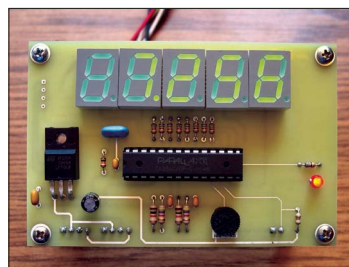




of the PCB. Each segment is connected to its respective buss lines from the bottom side (green) of the board with a via. A via looks like a pad, but it's smaller and its purpose is to route a signal between layers. After the segments were connected to the buss, the segment resistors were connected.

This was the only tricky part of the board layout as traces pass between pads — no worries, though, there is plenty of room and unless one is very clumsy with a soldering iron, there is little possibility of solder bridges. Figure 2 shows the timer layout using the standard Mini-Board form factor.

If you haven't used ExpressSCH and ExpressPCB, do give them a try — the design programs are free, and if you can fit your project into their Mini-Board format (as we did here), you can get three PCBs for \$62 and have them back in three business days after you place the order. One thing I want to



■ FIGURE 3. RaceTimer (front).

encourage you to do is learn to use ExpressSCH to create your schematics before moving on to ExpressPCB to lay out the board. I know, we're all in a time crunch but believe me, putting your project into ExpressSCH first will save you a lot of headaches. First, it will check all your connections and warn you of possible problems. Second, you can connect ExpressPCB to the ExpressSCH so that making connections on the board is much easier. You can see in Figure 2 that the pads in blue are supposed to be connected — I promise that this feature will save you lots of trouble and you'll be happy you spent the extra time with ExpressSCH.

Construction was straightforward. Like most, I start with the low-profile components first (resistors) and work my way up to the taller components. The connectors are soldered on the back, and I didn't actually put a connector into J3 (SX-Key/SX-Blitz); I simply used pads with small holes to make holding the Key/Blitz (equipped with a male-male header) against the board a little easier. Figures 3 and 4 show the front and back of my prototype PCB.

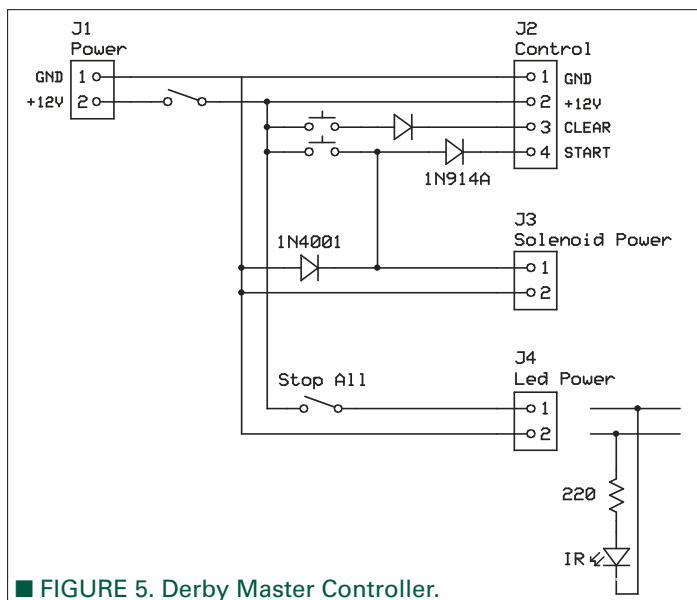
## LET'S RACE!

To put this project to work in a Pinewood Derby race track, you'll need to mount an LED source in the track at the finish line and the photo-transistor receiver above it (I used a source/detector pair from RadioShack). In my experiments with the timer, I found it works best when the photo-transistor is shielded with a plastic tube. With everything in place and powered, adjust R16 until the finish LED comes on, then back off until it goes off. Make sure that the LED goes full off — if it looks a bit dim then the comparator threshold has been very near the opto/10K junction voltage and the output is oscillating between on and off. Back R16 off a bit more until the LED is full off.

Figure 5 shows a suggested master controller for single- or multi-track setups. There's not much to this so it could be wired point-to-point, as I mentioned previously. Don't leave out the diodes if you're going to control a start solenoid from the power source used for the timer(s). The diodes will protect the power supply and control inputs to the timer(s) from any inductive kickback produced by the solenoid.

Okay, it's time to get your Pinewood racers out and get racing. With one millisecond resolution, you hardcore racers will have no trouble determining which car changes work and which don't.

Until next time, Happy Stamping. **NV**



■ FIGURE 5. Derby Master Controller.

**JON WILLIAMS**  
[jwilliams@efx-tek.com](mailto:jwilliams@efx-tek.com)

**EXPRESSSCH/  
EXPRESSPCB**  
[www.expresspcb.com](http://www.expresspcb.com)

**PARALLAX, INC.**  
[www.parallax.com](http://www.parallax.com)

# Simple LAN

## Microcontroller based web server

### Features:

- 10-BaseT Ethernet connection
- Easy to use interface
- Serve up to 31 Kbytes of files
- Receive data from HTML form GET messages
- 1200 bytes for web variables
- Send email with and without Login Authentication
- Send and receive UDP messages

\$29.95  
S&H



The Avcom TEC, LLC SimpleLan is a microcontroller based web server that is also capable of sending email and sending and receiving UDP messages. Configuration and adding files to the device is done using the easy to use SimpleLan Software. The SimpleLan can be used with any microcontroller or module that supports serial communication.

**Order on the Web. Credit Cards Accepted.**



213 East Broadway Ave.  
Westerville, OH 43081  
Phone: 614-882-8176  
scottw@avcomsmt.com

[www.avcomtec.com](http://www.avcomtec.com)

## USB/ETHERNET DAQ

**LabJack<sup>®</sup>  
UE9**



Available now  
for only ...

**\$429 qty 1**

USB/Ethernet Data  
Acquisition & Control

- \* USB 2.0/1.1 and Ethernet
- \* 14 analog inputs (12- to 16-bit)
- \* Stream input data up to 50 kHz
- \* Use with C, VB, LabVIEW, etc.
- \* Includes DAQFactory Express
- \* Operates from -40 to +85 deg C
- \* 2 analog outputs (12-bit)
- \* 23 digital I/O
- \* Up to 2 counters (32-bit)
- \* Up to 6 timers
- \* Approx. 3" x 7" x 1"



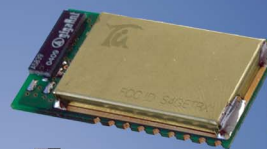
LabJack Corporation, Colorado, USA  
info@labjack.com, (303) 942-0228

[www.labjack.com](http://www.labjack.com)

## Going Wireless is Easy!

Mesh Networking

**ZigBee™**



**Bluetooth**

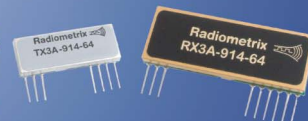
with Dip-Switch options



Multi-Channel

**900 MHz Wireless  
RF Modules**

**LE MOS  
INTERNATIONAL**



Call Toll Free 1-866-345-3667 or email at [sales@lemosint.com](mailto:sales@lemosint.com)

[www.lemosint.com](http://www.lemosint.com)

## GET A REAL LIFE

**Ready, set, go...  
get your dream job!**

**Make \$100,000 a year  
with NO college degree**

Learn Wireless Communications and get  
your "FCC Commercial License" with our  
proven Home-Study course.

Move to the front of the employment line  
in Radio-TV, Communications, Avionics,  
Radar, Maritime and more.

**No previous experience needed!  
Learn at home in your spare time!**

**Get FREE facts**

MAIL COUPON TODAY  
OR CALL TOLL-FREE!

**800-932-4268**

ext. 209

[www.LicenseTraining.com](http://www.LicenseTraining.com)

Send to: **COMMAND PRODUCTIONS**  
Warren Weagant's FCC License Training  
P.O. BOX 3000, Dept. 209 • SAUSALITO, CA 94966

Name: \_\_\_\_\_

Address: \_\_\_\_\_

City/State/Zip: \_\_\_\_\_

Or email us: [fcc@commandproductions.com](mailto:fcc@commandproductions.com)



# Q&A

## WHAT'S UP:

No matter what the project, they all need a power supply. But there are so many different kinds, it's hard to find the one suited for you. Here's a power supply overview.



Bypass caps demystified.



ATX makes benchtop supply.



"B" battery eliminator.



Power supply ripple meter.

### WITH TJ BYERS

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, comments, or suggestions.

You can reach me at: [TJBYERS@aol.com](mailto:TJBYERS@aol.com)

## BYPASS CAPS DEMYSTIFIED

Have you considered doing a column on power supply bypass capacitors for ICs? All the datasheets mention them but it is never clear how to choose the values or exactly what they do and how they do it. I know they bypass line noise but how do you determine the type of noise and values of the caps?

— Al Sanowskis  
Ocala, FL

No, I haven't given it much thought because it's akin to walking into quicksand. Once you step into the quagmire, you're in over your head. But I've been there before, so why not again? First, let me define the difference between bypass and decouple. The two terms are used loosely and often interchangeably. However, they're not one and the same.

Bypass is the reduction of high-frequency current flow in a high-impedance path — typically the power input of an op-amp, logic gate, or switching device — by shunting the current to ground via a capacitor. It's normally used to reduce noise on power supply lines. Decoupling is the isolation of two

circuits on a common line, and normally consists of an LC low-pass filter. Decoupling is used to prevent transmission of noise from one circuit to another. When used for bypassing, decoupling circuits will often give disappointing, if not disastrous, results. For this discussion, I will focus on bypass capacitors.

It all starts with the power supply. Before voltage ever reaches the IC, it must run a gauntlet of PC board track resistance, stray inductance, and capacitive loading. Taken together, these elements represent time delays. Let's take the case of a logic gate driving a capacitive load. When the output of the gate goes high, it draws a surge of current as the load capacitor charges. Enter the stray inductance in the track. Inductors hate a change in current, and this inductor is no different, trying with all its might to prevent the current from rising to meet the demands of the new logic state. As a result, there is a dip in the line voltage — a dip that can and does affect the performance of the IC and the circuit. It is the responsibility of the bypass capacitor to compensate for this voltage glitch.

It does this by using its stored charge. As much as an inductor hates a change in current, the capacitor hates a change in voltage. And to prevent a change, it will give up its

charge to smooth out the bump. The trick is to match the capacitance of the capacitor to the energy needed to fill the voltage droop while at the same time not introduce problems of its own. There are two factors in conflict. For minimum voltage drop, you need a large capacitance. But the larger the cap, the more internal resistance and inductance it comes with — another venue for possible signal delay. What you need is a capacitor that's a compromise between the warring factions.

Calculating the value of the capacitor can be daunting. For those readers who like numbers, here are the equations. The first calculates the voltage droop of the power supply line using the trace inductance and  $dI/dt$ , where  $dt$  is the duration of the power surge. This value can often be found from the datasheet. For example, a microprocessor's current transients are on the order of one to 20 ns, while a typical voltage converter has a reaction time of one to 100  $\mu$ s.

$$dV = L \frac{dI}{dt}$$

For the sake of argument, let's say  $dt$  is 50 ns, the current change is 500 mA, and the stray inductance is 20 nH. Plugging in the values, we get:

$$dV = 2 \times 10^{-8} \frac{0.5}{5 \times 10^{-8}} = 200 \text{ mV}$$

The formula for calculating the bypass capacitance is:

$$C = \frac{dI \, dt}{dV}$$

$$C = \frac{(0.5)(5 \times 10^{-8})}{0.2} = 0.125 \, \mu\text{F}$$

Although it's not spot on, a 0.1  $\mu\text{F}$  bypass capacitor should fit the bill. However, switched current pulses never travel alone. They come with a family — a family of harmonics, or overtones. A rise time of 50 ns is equivalent to a fundamental frequency of 20 MHz, which contains third and fifth harmonics of 60 and 100 MHz, respectively. Doing the math, we see that 60 MHz and 100 MHz have bypass capacitor requirements of .014 and .005  $\mu\text{F}$ , respectively. Rule of thumb: the higher the frequency, the smaller the bypass capacitor. For those readers who deal better with pictures than numbers, the graph in Figure 1 shows examples of capacitance versus switching frequency.

Like overtones, bypass capacitors often cluster together. It's not uncommon to see more than one bypass capacitor hanging off the Vcc lead of a single IC — with each cap targeting a slightly different frequency. The circuit in Figure 2 shows me

using three different bypass capacitors in parallel on a single IC power pin. The 4.7  $\mu\text{F}$  cap is used to catch larger voltage dips that are at relatively low frequencies, like 120 Hz ripple from the power supply. The 0.1  $\mu\text{F}$  cap soothes the fundamental frequency, while the .01  $\mu\text{F}$  cap tackles the harmonics.

When specifying capacitors for bypass, you also need to consider the equivalent series resistance (ESR). This is resistance that's internal to the capacitor and in series with the cap — resistance that can limit the amount of discharge current. The lower the ESR, the faster the cap will respond to voltage droop. As a rule, larger value capacitors have more ESR than smaller ones. Therefore, it is common to parallel two smaller caps than to use one large one for lower overall ESR. But bypass capacitors have inductance of their own. Like ESR, this inductance further limits discharge current. However, parallel resistance is subtractive whereas parallel inductance is additive. So, while ESR decreases with additional parallel capacitors, the inductance increases, thus forcing a practical limit on the number of parallel capacitors. The ideal bypass capacitor has both zero ESR and zero inductance. See Table 1 for a comparison of bypass capacitor types.

Many schematics that you find

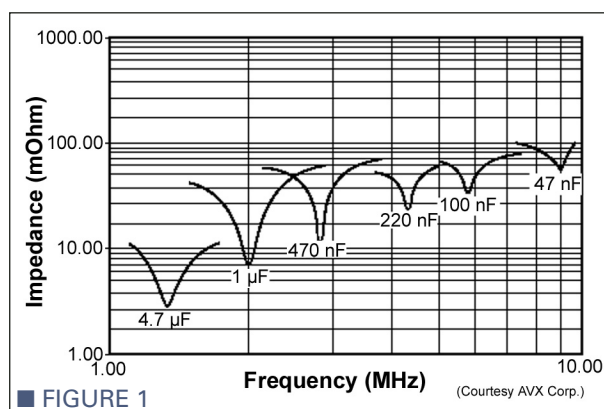


FIGURE 1

(Courtesy AVX Corp.)

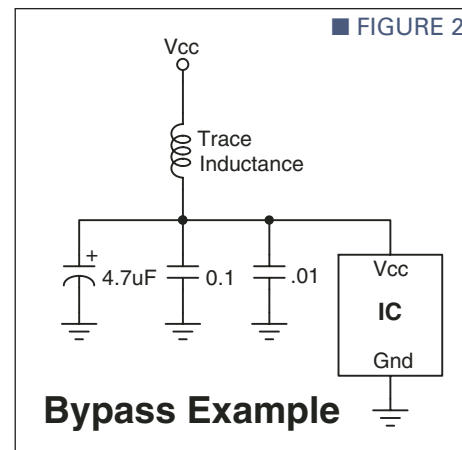


FIGURE 2

published in magazines (my column included) and books leave the bypass capacitors out. It's assumed you know to put them in. Other times, you will find a little row of capacitors stuck off in the corner of the schematic with no apparent function. These, too, are bypass capacitors, just collectively bunched for schematic clarity. When working with any digital circuit, don't forget the bypass capacitors even if they aren't specifically expressed.

|             | Tantalum               | Aluminum                 | Ceramic                  | Polyester               | Polyethylene           | Polystyrene             | Polypropylene          | Polyphenylene           |
|-------------|------------------------|--------------------------|--------------------------|-------------------------|------------------------|-------------------------|------------------------|-------------------------|
| ESR         | Low                    | Good                     | Medium                   | Low                     | Low                    | Very Low                | Very Low               | Very Low                |
| Inductance  | Medium                 | Medium-High              | Low                      | High                    | High                   | Low                     | Medium                 | Medium                  |
| Capacitance | 0.1-1500 $\mu\text{F}$ | 0.1-43,000 $\mu\text{F}$ | 0.1 pF-100 $\mu\text{F}$ | .0001-160 $\mu\text{F}$ | .001-4.7 $\mu\text{F}$ | 22 pF-2.0 $\mu\text{F}$ | 68 pF-22 $\mu\text{F}$ | .0001-1.0 $\mu\text{F}$ |
| Voltage     | 2V-125V                | 6.3V-450V                | 6.3V-50kV                | 50V-1kV                 | 16V-400V               | 50V-630V                | 50V-3kV                | 10V-100V                |
| Polarized   | Yes                    | Yes                      | No                       | No                      | No                     | No                      | No                     | No                      |
| Failure     | Short                  | Open                     | Short                    | Open                    | Open                   | Open                    | Open                   | Open                    |
| Size        | Small                  | Medium                   | Small                    | Medium-Large            | Large                  | Large                   | Large                  | Medium-Large            |
| Cost        | High                   | Low                      | High                     | Low                     | Medium                 | Low                     | Medium                 | High                    |

TABLE 1. Bypass Capacitor Comparison.



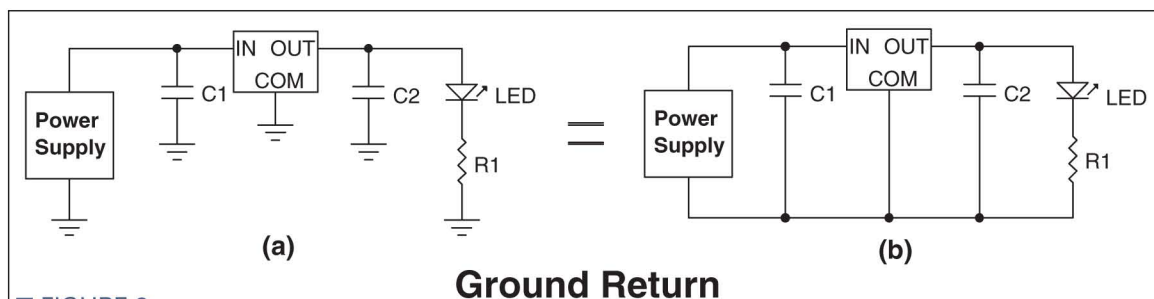


FIGURE 3

## Ground Return

## FROM EARTH TO GROUND

I am a newbie to the world of electronics, and every day there are questions popping up in my head. For example, could you explain why all the electronic schematics require ground? And what actually does ground mean? I would appreciate if you could recommend a book for beginners that shows how to read a schematic diagram.

— Gene

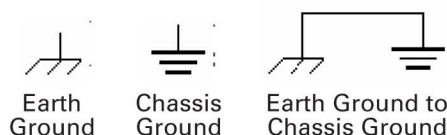
I assume you are talking about the “screw” that populates nearly every schematic in this magazine. Although

it’s referred to as ground, it really isn’t. It simply represents a return path for the power supply. Consider the schematics in Figure 3. Notice that the ground symbols in Figure 3a have been removed and replaced with wires in Figure 3b. These “ground” all connect to a common terminal of the power supply — usually the negative terminal — and are often used for the zero-voltage reference. In other words, the symbol is nothing more than a shortcut — one that cleans up wire clutter on complex drawings. Sometimes the ground includes the metal chassis of a device, hence the name chassis ground (but increasing less so nowadays).

Why is it called ground? One story has it as a leftover from radio days when Earth ground was used to carry current between buildings and to the transmitting tower. You old timers may remember the “phantom grounds” of yesteryear. Some say it’s because the power companies bury the neutral line of the AC power lines directly into the Earth. However, the Earth connection has a symbol of its

so specified.

If you’re looking for a book for beginners, I recommend *Beginner’s Guide to Reading Schematics* by Robert J. Traister and Anna L. Lisk, available from [Amazon.com](http://Amazon.com). Also check out the website at [http://arts.ucsc.edu/EMS/Music/tech\\_background/schematics/ReadSchem.html](http://arts.ucsc.edu/EMS/Music/tech_background/schematics/ReadSchem.html)



## FROM ATX TO BENCHTOP

I have access to a number of ATX computer power supplies. Is there anything I should know before I connect them to regulators to provide power for my bench projects? I saw a web page for an ATX modification while surfing the Internet, but I have forgotten what site it was on and don’t remember the particulars.

— Charlie

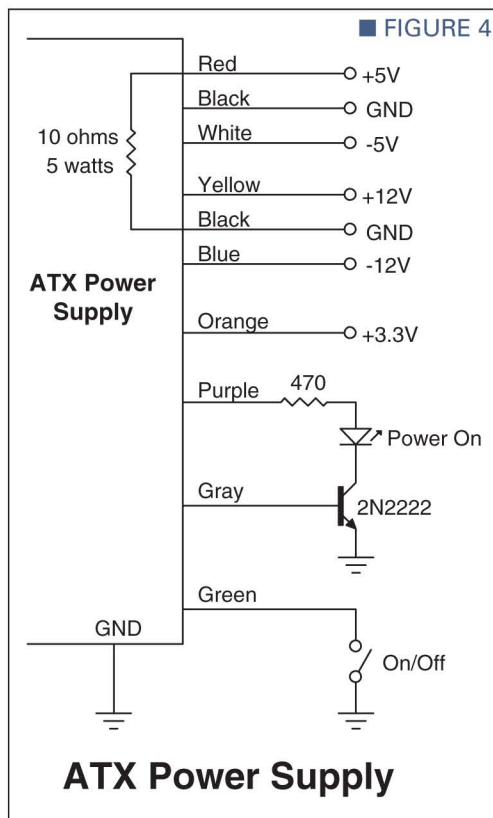


FIGURE 4

| Color  | Function | Min. Current | Max. Current | Comment                                 |
|--------|----------|--------------|--------------|---|
| Red    | +5V      | 0.3A         | 30A          | Requires 10 ohm min. current load       |
| Yellow | +12V     | 1.0A         | 15A          | 19A peak for 17 seconds, one per minute |
| Orange | +3.3V    | 0.5A         | 28A          | Optional bench voltage                  |
| Black  | GND      | —            | —            | Use separate wires for 5V and 12V       |
| White  | -5V      | 0            | 0.3A         | Undefined in Version 2.2                |
| Blue   | -12V     | 0            | 0.8A         | ±10 voltage regulation                  |
| Purple | +SB      | —            | 2.0A         | +5V regulated, always available         |
| Gray   | PWR_OK   | —            | 4 mA         | Goes high (+5V) at power on             |
| Green  | PS_ON    | —            | —            | Short to GND for power on               |

TABLE 2. ATX Features and Specifications.

**A** The website I think you encountered is [www.wikihow.com/Convert-a-Computer-ATX-Power-Supply-to-a-Lab-Power-Supply](http://www.wikihow.com/Convert-a-Computer-ATX-Power-Supply-to-a-Lab-Power-Supply) or [http://web2.murraystate.edu/andy.batts/ps/POWER\\_SUPPLY.HTM](http://web2.murraystate.edu/andy.batts/ps/POWER_SUPPLY.HTM) It describes how a hobbyist converted an ATX power supply into a 5/12-volt bench supply. Here's a fast recap of the project, with a few comments of my own (of course!).

The ATX (advanced technology extended) form factor was introduced by Intel in 1995 to standardize power supply size and to accommodate the new Pentium voltage and current requirements. Besides a new size with a standard hole pattern, the ATX added a +3.3 volt source — and a new power-on routine. Unlike the AT, the ATX power supply is never completely off. Instead, it goes into a sleep mode where standby power is available for housekeeping, LAN awakening, and other chores. The ATX voltages and associated wire colors are shown in Table 2.

Begin by clipping off the 20-pin Molex connector and proceed to untangle the wires. You will have more wires than you need, so now is a good time to winnow them out. You'll need two red wires (+5V), two orange wires (+3.3V, if used), two black wires (GND), and one each of the remaining colors. Route and solder the voltage wires to an accommodating binding post or connector of your choice. If your power supply has a brown lead (+3.3V sense), connect it to the orange wire. Two wires are ATX control lines, and need to be treated as such. The first is the green Power Supply On (PS\_ON) wire. When this lead is grounded (connected to a black wire), it enables the outputs and turns on the power supply, provided the output voltages are up and running. If the output voltages fall below 5% of its rated value, the gray Power OK (PWR\_OK) line goes high (+5 volts). This output can be used to power an on/off LED, as shown in Figure 4. Clip and remove any unused wires at the circuit board.

Because the ATX is a switching power supply, it requires a load for

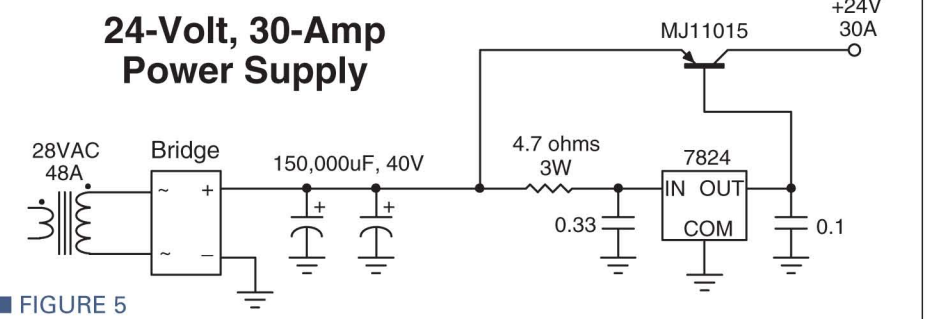


FIGURE 5

proper operation. Without a load, some older ATX units could fail, taking a lot of expensive transistors with it when it does. Fortunately, the supply isn't fussy about where the load comes from. Any output will do. Since the +5V line has the most to give, putting a 10 ohm resistor across this output will suffice. Be forewarned that this resistor will get hot — about 2.5 watts hot, to be exact — so place it accordingly. Most mods recommend mounting it to the metal chassis, which now acts as a heatsink.

## NEEDS 24 VOLTS AT 30 AMPS

**Q** I need a voltage regulator that can control 20 to 30 amps at 24 volts. I will be using the supply for stepper motors. The stepper motors I have on my CNC machine are 4.7 amps per phase — that's 9.4 amps per motor and three motors (one per axis) equals 28.2 amps total. I have looked at the LM723 voltage regulator, but all the schematics I've seen use 2N3055 transistors and none are able to handle 30 amps. Can I use a MOSFET? Will it lower the cost of the power supply and require a smaller heatsink?

— TJ Henley

**A** To begin with, the LM723 is a linear voltage regulator (not recommended for new designs) and requires a linear pass transistor like the 2N3055 to increase the output current. MOSFETs, on the other hand, are typically switching devices that are better suited for switching

regulators than for linear regulators.

In place of the LM723, I'd use a 7824 linear regulator, like the L7824, LM7824, or UA7824. And rather than using a stack of 2N3055 transistors, a Darlington power transistor — like the MJ11015 — would be a better choice. You need only one, and it consumes less base current than a 2N3055 which, in turn, lets the transistor run cooler. (Still, you need to dissipate about 90 watts — the power needed to maintain a three-volt drop across the collector to emitter — to regulate the voltage, so a heatsink is required.) The 7824 is used to regulate the output at 24 volts by controlling the base current through the MJ11015 (Figure 5).

All that's left is to provide enough DC power for the regulator and stepper motors. That will require a 28 VAC, 48 amp transformer, a bridge rectifier, and about 260,000 µF of filtering. I would put two 150,000 µF caps in parallel because together they gave less ESR (equivalent series resistance) than a single unit. They're also cheaper — if you call \$30 a pop cheap. Fortunately, there is a way to electronically create a large capacitor using a capacitance multiplier. The circuit in Figure 6 can

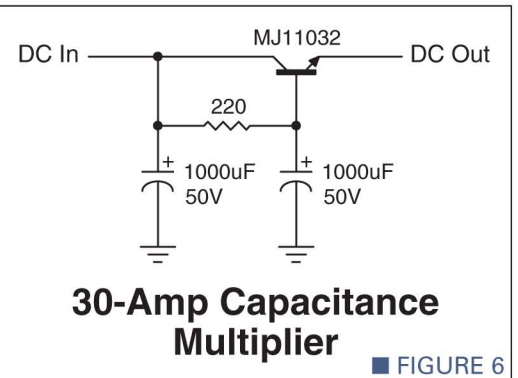


FIGURE 6



## Power Supply Ripple Meter

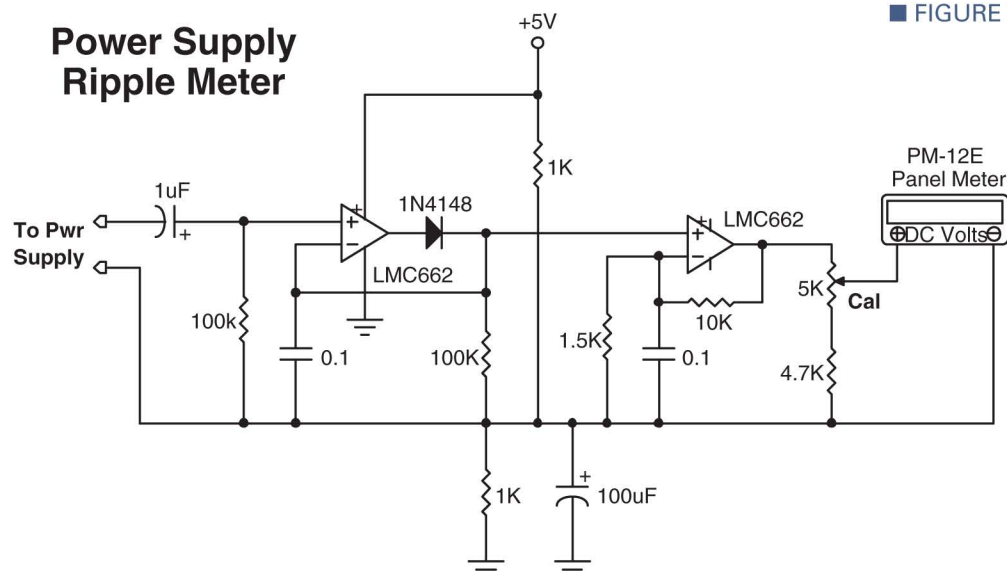
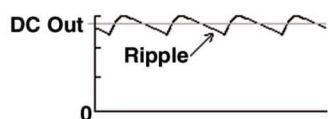


FIGURE 7

time average of a sine wave is zero. So, what they do is square the signal, which makes everything positive, average this, and then take the square root to arrive at an average voltage. The circuit in Figure 7, on the other hand, is a peak detecting voltmeter. To convert peak voltage to RMS, you simply multiply the peak voltage by 0.707 – or turn the Cal pot until the meter reads 0.7 peak volts. (If you wish to measure peak volts, turn the Cal pot fully clockwise.)

The first stage of the voltmeter is a peak voltage detector. A 1  $\mu$ F input cap



## Power Supply Ripple

FIGURE 8

replace the two 150,000  $\mu$ F caps – with a 1F equivalent – for less than \$15.

## POWER SUPPLY RIPPLE METER

Do you have a circuit that can be used to monitor the AC ripple voltage on the output of a 12-volt linear power supply? I know it can be done with a scope, but I am looking for something simpler – something with numbers on it, preferably with a digital readout display.

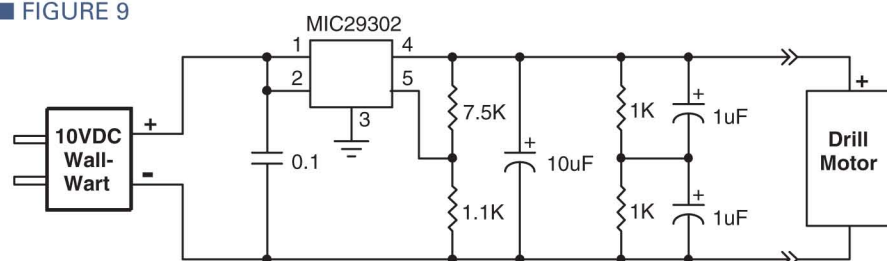
— Bill

When AC voltage is rectified, it produces a pulsing DC voltage that is smoothed out using a filter, typically a large electrolytic capacitor. Ripple is the amount of fluctuation left over after the filtering, and it varies with the load. As the power supply output current increases, so does the ripple. Ripple is measured in peak-to-peak (P-P) or root-mean squared (RMS) volts. The AC millivoltmeter in Figure 7 measures both, depending on the setting of the Cal potentiometer.

Unlike a switching power supply, which tosses voltage spikes around like flakes in a snow flurry, a linear power supply's ripple is largely a 120 Hz repetitive wave form that looks like a distorted sine wave (Figure 8). As a result, the ripple (sometimes called hum) is often expressed in RMS. RMS is a clever way to measure average voltage when the voltage is AC. Since half of the time the wave form is positive and half the time it is negative, the

blocks the power supply's DC voltage. When this AC signal is placed on the non-inverting input, the output goes high and charges the 0.1  $\mu$ F cap. The 1N4148 diode prevents the capacitor from discharging through the op-amp when the input voltage drops below the peak. This voltage is amplified by the second op-amp and fed to the DVM (an analog meter will work, too), where it is displayed as ripple. The full-scale range of this design is 250 mV, but you can make it more or less sensitive by playing with the value of the 1.5K resistor. To calibrate the ripple meter, place a 1K resistor in series with a 20 ohm resistor across the secondary of a 12.6 VAC transformer. The voltage drop across the 20 ohm resistor is 0.247 volts. Use the ripple meter to measure the voltage across the resistor and adjust Cal to read 175 mV – the RMS value. The panel meter is a PM-12E from Circuit Specialists ([www.circuitspecialists.com/prod.item/icOid/7077](http://www.circuitspecialists.com/prod.item/icOid/7077)). Set the jumpers for a 20 volt DC display and a five-volt power source.

FIGURE 9



## Mikita Battery Pack Adapter

## PORTABLE DRILL GETS A TETHER

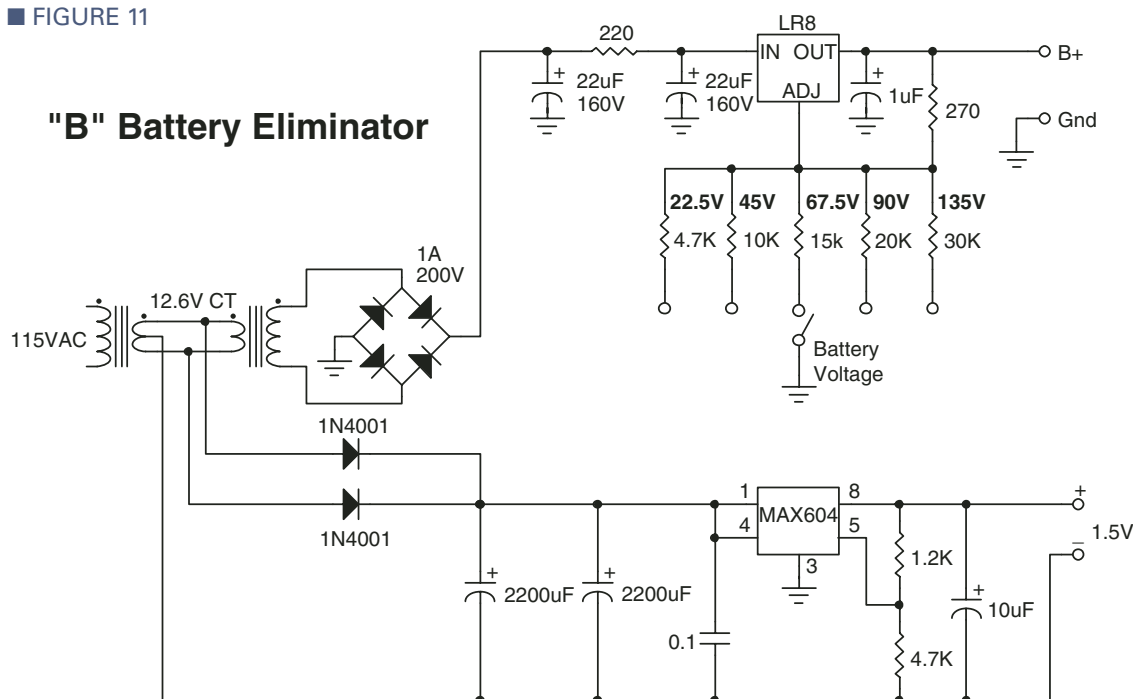
I was wondering if you know how much current a Makita 9.6 volt portable drill draws from a fully-charged battery





FIGURE 11

## "B" Battery Eliminator



practice in the old days, and behaves like an RC pi network, which permits smaller filter capacitors with no increase in ripple.

Since most tube-operated equipment also used an "A" battery that powered the tube filaments, I included a 1.5-volt output at 500 mA. The best chip for this purpose turns out to be the MAX604 from Maxim. Unlike the three-lead LR8 — which

uses a voltage across a fixed resistor to set the output voltage — the MAX604 has a feedback path that defines the output voltage by comparing it to a voltage tapped from an external resistance divider. This arrangement proves very stable when regulating voltages below three volts. Notice that the 1.5-volt source doesn't share a common ground with the B+ supply. This is typical of battery-operated tube

equipment. Many tubes didn't have a separate cathode, which forced the filaments to float above ground — so don't be tempted to tie them together.

Also take note that this battery eliminator has two input transformers, back to back. This arrangement provides the six volts AC for the 1.5 volt source while, at the same time, provides isolation from the AC line. Any 12 volt transformer at 0.5A or better will do,

including the RadioShack 273-1365, if you limit the 1.5 volt "A" battery current to 300 mA. **NV**

## COOL WEBSITES

Google DOCs is here. So is Google spreadsheet. And Google Desktop. In fact, Google is becoming a full-fledged PC apps solution. Check it out.

Sketchup

[www.sketchup.com](http://www.sketchup.com)

Writely and spreadsheet

[www.google.com/accounts/ServiceLogin?service=writely&passive=true&continue=http%3A%2F%2Fdocs.google.com%2F&ltmpl=WR\\_tmp\\_2\\_lfty&nui=1](http://www.google.com/accounts/ServiceLogin?service=writely&passive=true&continue=http%3A%2F%2Fdocs.google.com%2F&ltmpl=WR_tmp_2_lfty&nui=1)

Navigator — search engine

[www.google.com/options/defaults.html](http://www.google.com/options/defaults.html)

Google Desktop — fun gadgets, world clock, Reversi, etc.

<http://desktop.google.com/>

Maps and location navigation

<http://maps.google.com/>

## IP Home Automation Development

Embedded Web Server, Ethernet, Wireless 802.15.4 (Zigbee)

### WPAN-GW1 \$89

- Embedded Web Server
- 10mbps Ethernet LAN Connectivity
- 40MHz PIC18F6722
- 2Mbyte Data Flash
- RS-232 Debug/Monitor
- Optional 802.15.4 (Zigbee) Module
- MPLAB In-Circuit Debug Support

### WPAN-GW1 Kit \$119

- WPAN-GW1 Board
- Enclosure
- Power Supply
- Cables — RS-232, Ethernet
- CD with Manual & Software

### Development Support

Open Source & Low Cost Resources

- RTOS — PICOS18 and FreeRTOS
- MPLAB IDE, ICD 2, C18 Compiler
- TCP/IP Stack, Ethernet Driver
- Zigbee Stack, 802.15.4 Driver
- Microchip Boot-Loader
- Eagle Student/Hobby Edition
- DHTML & AJAX Examples
- Design Guides

### Engineering Design Packages \$39-\$49

- CadSoft Eagle Design with Schematic, Parts Library, PCB, & Manufacturing Files
- Engineering Design Manual



**MicroAutomata**



Order online [www.microautomata.com](http://www.microautomata.com)  
email: [sales@microautomata.com](mailto:sales@microautomata.com)  
(256) 513-4775

# 1,300+ Products for the Hobbyist, Inventor, & Engineer

Free Forums and Resources  
[www.DesignNotes.com](http://www.DesignNotes.com)

## Plastic & Aluminum Project Cases



As Low As \$5.80

## Connectors & Adapters



As Low As \$0.40

## 100's of Kit Projects



Remote Control  
By Telephone  
Only \$65.00

K6501

## Test Equipment

USB PC 2 CH  
60MHZ

Oscilloscope

Includes 2  
Probes! \$334.95

**New Product**



PCSU1000

Free with orders  
over \$100.00

DVM850BL  
Digital Multimeter



1 year  
Subscription to  
**NUTS & VOLTS**  
(Print Edition)

or

**DesignNotes.com**  
Affordable Prototyping Products

Toll Free  
1-800-957-6867

15 Day Money Back Guarantee  
DesignNotes.com, Inc  
2014 Ford Road, Unit B • Bristol, PA 19007



# Nuts & Volts 2005 CD-Rom Now Available!

It's here! The complete 2005 year of  
**Nuts & Volts** on CD. Stored as PDFs, you  
can print, search, and easily store your  
digital magazine.

To order, go to:  
[www.nutsvolts.com](http://www.nutsvolts.com)  
or call  
**1.800.783.4624**

Now Only  
**\$24.95**

Buy 2 or more CDs  
for only \$19.95 each.  
Price does not include S/H.

# GREAT NEW PRODUCTS! NEW VALUES!

80,000 COUNT & 50,000 COUNT DMM'S

**MODEL 6800**  
80,000 Count

- +/- 0.05% Basic DC Accuracy
- Pulse Output with Variable Duty Cycle
- Frequency, mS Pulse Width and Duty Cycle
- AC and AC + DC True RMS
- RS 232 Interface

\$194 User Price



**MODEL 6500**  
50,000 Count

- 50 Segment Back Lit Bar Graph
- +/- 0.03% DC Accuracy
- RS232 Interface
- dB measurement
- AC and AC + DC True RMS
- Frequency, Duty Cycle and Capacitance

\$173 User Price



## MORE VALUE-ADDED INSTRUMENTS

2, 4, 10 &  
20 MHz,  
Sweep  
and Pulse  
Generators

From \$253



20 to 30 MHz,  
Dual Trace  
Analog Scopes  
From \$449

Freq'y Counters  
1.3 to 3 GHz  
From \$277



Protek Products are Distributed Nationally. Visit [www.protektest.com](http://www.protektest.com)  
for the name and location of your local distributor. Ask for our latest catalog.

**Protek**  
Test and Measurement

45 Smith St., Englewood, N.J. 07631  
Tel: 201-227-1161 • Fax: 201-227-1169  
e-mail: [sales@protektest.com](mailto:sales@protektest.com)



# HAPPY NEW YEAR!

## USB Experimenters Kit



### Learn how USB works!

Get hands-on experience developing USB interfaces! 5 digital inputs, 8 digital outputs, 2 analog I/O's! Includes diagnostic software and DLL for use with Windows based systems. The mystery is solved with this kit!

K8055 USB Exp. Kit 44.95

## High Power LED Strobe



### Super bright LED's!

The fragile glass Xenon tube is gone, replaced with high intensity LED's! Variable flash rate and built-in audio trigger input to sync to your audio. Additional display boards also available. Runs on 12VDC or use our AC125 PS.

LED51C LED Strobe Kit 44.95

## Personal Guitar Amp



### Brand new, popular choice!

The new PGA1 allows you to practice both your regular and bass guitars in peace! Also works as a great DI to feed your home stereo amplifier! CD/MP3 input allows you to play to your favorite music. Includes case shown!

PGA1 Guitar Amp Kit 64.95

## Tickle-Stick



The kit has a pulsing 80 volt tickle output and a mischievous blinking LED. And who can resist a blinking light! Great fun for your desk. "Hey, I told you not to touch!" Runs on 3-6 VDC

TS4 Tickle Stick Kit \$12.95

## Super Snoop Amplifier



Super sensitive amplifier that will pick up a pin drop at 15 feet! Full 2 watts output. Makes a great "big ear" microphone. Runs on 6-15 VDC

BN9 Super Snoop Amp Kit \$9.95

## Dripping Faucet



Produces a very pleasant, but obnoxious, repetitive "plink, plink" sound! Learn how a simple transistor oscillator and a 555 timer can make such a sound! Runs on 4-9 VDC.

EDF1 Dripping Faucet Kit \$9.95

## Touch Switch



Touch on, touch off, or momentary touch hold, your choice! Uses CMOS technology. Runs on 6-12 VDC and drives any load up to 100 mA.

TS1 Touch Switch Kit \$9.95

## Voice Switch



Voice activated (VOX) provides a switched output when it hears a sound. Great for a hands free PTT switch, or to turn on a recorder or light! Runs on 6-12 VDC and drives a 100 mA load.

VS1 Voice Switch Kit \$9.95

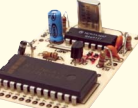
## LED Blinky



Our #1 Mini-Kit for 31 years! Alternately flashes two jumbo red LED's. Great for signs, name badges, model railroading, and more. Runs on 3-15 VDC.

BL1 LED Blinky Kit \$7.95

## DTMF Tone Decoder



Decodes DTMF Touch Tones from telephones, radios, etc. 200mA output drives relays, LEDs, digital devices, and more. Decodes 0-9, \*, #, A, B, C, D. Runs on 5VDC

TT7 DTMF Decoder Kit \$24.95

## Stereo Super Ear



The stereo Super Ear features an ultra high gain audio amp with two sensitive microphones! Boosts audio 50 times! Includes volume control. Runs on 3 AAA batteries.

MK136 Stereo Super Ear Kit \$9.95

## Light Activated Switch



Save electricity and have your devices turn off at dusk, on at dawn! Closes an on-board SPDT relay. Adjustable sensitivity over a wide range. Runs on 12-15VDC.

MK125 Light Activated Switch Kit \$7.95

## Water Sensor Alarm



The sump pump quits...and what do you do? You don't live in the basement! This cute little sensor detects water and sounds an alarm to let you know! Simply mount the alarm contacts in the area you want to detect. The sensor section can even be remotely located from the alarm! Runs on a standard 9V battery (not included).

MK108 Water Sensor Alarm Kit \$7.95

## ECG Heart Monitor



### Check your own heart!

Provides a visible and audible display of your heart rhythm! Variable gain, bright "beat" LED, and monitor output for display on your scope. Just like the lab! Reusable sensors are included. Runs on a safe 9VDC battery.

ECG1C ECG/EKG Kit 44.95

## Plasma Generator



### Generate 2" sparks!

Produces a stunning and shocking 25kV at 20kHz from a solid state circuit! Build your own plasma bulbs, light fluorescent tubes without wires and more! A great learning kit. Runs on 16VAC, order our PS21 power supply.

PG13 Plasma Gen Kit 64.95

## HV Ion Generator



### Make a blast of fresh air!

Generates a steady state DC voltage at constant non-pulsed current at 7.5kV DC negative, 400uA. That's a LOT of ions! Learn how modern spacecraft use ions to accelerate through space. Runs on 12VDC or our AC125 PS.

IG7 Ion Gen Kit 64.95

## 20W SubMini Audio Amp



### 20 watts and no heat!

Delivers a super clean 20W output from one SMT package! Ultra efficient class D design produces no heat. PCB can be snapped into a small circle for special applications. Runs on 18VDC for rated output, use our SP518 PS.

UAM2 20W SMT Amp Kit 34.95

## Digital Voice Storage



### Multiple message storage!

The Bullshooter-II provides up to 8 minutes of digital voice storage that can be broken down into 8 separate stored messages! Great for announcements, etc. Built-in mic plus external input. Runs on 12VDC or our AC125 PS.

BS2C Bullshooter-II Kit 69.95

## Speed Radar Gun



### Now YOU can be the cop!

Our famous Speedy radar gun teaches you doppler effect the fun way! Digital readout displays in MPH, KPH, or FPS. 1/8th mile range is typical. You supply two coffee cans! Runs on 12VDC or our AC125 power supply.

SG7 Speedy Radar Kit 59.95

## Doppler Direction Finder

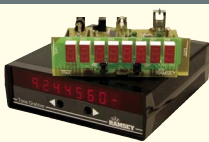


### Find that transmitter quick!

Track down jammers and hidden transmitters with ease! 22.5 degree bearing indicator with adjustable damping, phase inversion, scan and more. Includes 5 piece antenna kit. Runs on 12VDC vehicle or battery power.

DDF1 Dir. Finder Kit 169.95

## Touch-Tone Reader



### Read the number dialed!

The Tone Grabber captures dialed phone numbers, repeater codes, control codes, or anything that uses touch-tone signaling. Flash micro stores 640 digits! Phone line and audio inputs. Runs on 12VDC or our AC125 PS.

TG2C Tone Grabber Kit 69.95

## Signal Magnet Antenna



### Pulls in distant stations!

Super Hi-Q ferrite rod antenna with Faraday shield eliminates noise from power lines, dimmers, static and more! Great results from 500kHz to 15MHz. Super for AM broadcast band! Includes power supply.

SM100 Sig Magnet Kit 89.95

## Did You Know...

- ✓ It's impossible to give you full specs on these products in a 1" space!
- ✓ A lot of our kits are also available "factory assembled and tested", if you don't want to build it!
- ✓ We have over 350 products currently available, and all those don't fit here!

## The Solution!

Visit [www.ramseykits.com](http://www.ramseykits.com)  
Free Giveaways and ALL the information you ever needed!

# It's A Great New Year... And Time To Have Fun With Electronics!

## Build It, Learn It, Achieve It, Enjoy It!

### Electronic Learning Labs

- ✓ Learn and build!
- ✓ 130, 200, 300, and 500 in one!
- ✓ Super comprehensive training manuals!

Whether you want to learn the basics of electricity, the theory of electronics, or advanced digital technology, our lab kits are for you! Starting with our PL130, we give you 130 different electronic projects, together with a comprehensive 162 page learning manual. A great start for the kids...young and old!

New for 2007, check out the PL200! Its unique design has an integral front panel that includes controls, meter, display and more for full control of your projects!

Not enough? Next is our PL300, which gives you 300 separate electronic projects along with a 165 page learning and theory manual. The PL300 walks you through the learning phase of digital electronics.

If you're looking for the ultimate lab kit check out our PL500. Includes a whopping 500 separate projects, a 152 page starter course manual, a 78 page advanced course manual, a hinged easy to carry case, and a 140 page programming course manual! The PL500 covers everything from the basics to digital programming! Learn about electronics and digital technology the fun way and build some neat projects! Whichever one you choose, you will have hours of enjoyment!

|       |                                      |          |
|-------|--------------------------------------|----------|
| PL130 | 130 In One Learning Lab Kit          | \$42.95  |
| PL200 | 200 In Super Fun Learning Lab Kit    | \$54.95  |
| PL300 | 300 In One Complete Learning Lab Kit | \$69.95  |
| PL500 | 500 In One Advanced Learning Lab Kit | \$169.95 |

### Passive Air Band Aircraft Monitor

- ✓ Monitors the entire aircraft band without tuning!
- ✓ Passive design, can be used on aircraft, no local oscillator, generates and creates no interference!
- ✓ Great for air shows
- ✓ Patented circuit and design!

This broadband radio monitors transmissions over the entire aircraft band of 118-136 MHz. The way it works is simple. Strongest man wins! The strongest signal within the pass band of the radio will be heard. And unlike the FM capture effect, multiple aircraft signals will be heard simultaneously with the strongest one the loudest! And that means the aircraft closest to you, and the towers closest to you! All without any tuning or looking up frequencies! So, where would this come in handy?

1. At an air show! Just imagine listening to all the traffic as it happens
2. Onboard aircraft to listen to that aircraft and associated control towers
3. Private pilots to monitor ATIS and other field traffic during preflight activities (saves Hobbs time!)
4. Commercial pilots to monitor ATIS and other field traffic as needed at their convenience
5. General aircraft monitoring enthusiasts

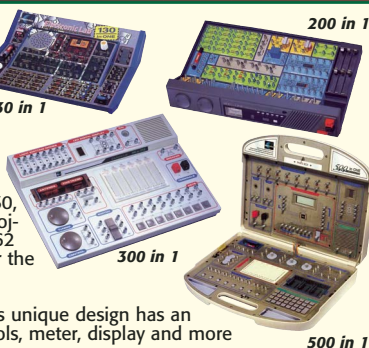
Wait, you can't use a radio receiver onboard aircraft because they contain a local oscillator that could generate interfering signals. We have you covered on that one. The ABM1 has no local oscillator, it doesn't, can't, and won't generate any RF whatsoever! That's why our patent abstract is titled "Aircraft band radio receiver which does not radiate interfering signals". It doesn't get any plainer than that!

Available as a through-hole hobby kit for easy do-it-yourself assembly or a factory assembled & tested SMT version to operate right out of the box! Join in the excitement of monitoring your local aircraft the easy way, with our patented tune-free receiver! Operates on a standard 9V battery, not included.

|        |  |          |
|--------|--|----------|
| ABM1   | Passive Air Band Monitor Kit                         | \$89.95  |
| ABM1WT | Passive Air Band Monitor, Factory Assembled & Tested | \$159.95 |



590 Fishers Station Drive  
Victor, NY 14564  
(800) 446-2295  
(585) 924-4560



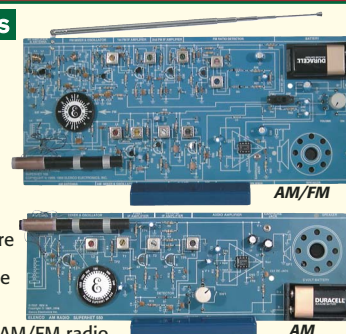
### Integrated Circuit Radio Labs

- ✓ Learn all about AM and FM radio theory and circuits!!
- ✓ Build an IC based radio with great reception!
- ✓ Step-by-step assembly & test procedures!
- ✓ Great to learn about IC's!

These Superhet AM and AM/FM radio kits give you a great introduction to how AM and FM radios actually work! Plus, they are designed using integrated circuits rather than standard discrete components. These are the perfect kits to learn all about IC design, theory, and troubleshooting! And when you're done you have an AM or an AM/FM radio that has really great reception...that you made yourself!

IC's, transistors, resistors, capacitors, coils and other parts are easily identified, and described in theory. The comprehensive manual includes step-by-step assembly and test procedures, and complete theory. The final alignment section is also provided to make sure you have a great sounding receiver! 9V battery required.

|          |   |         |
|----------|---|---------|
| AMFM108K | AM/FM Integrated Circuit Radio Learning Kit | \$34.95 |
| AM550K   | AM Integrated Circuit Radio Learning Kit    | \$22.95 |



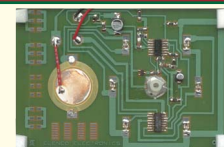
### Surface Mount Soldering Course & Kit

- ✓ Learn SMT soldering the easy way!
- ✓ Learn all about those tiny parts!
- ✓ Includes SMT training sessions
- ✓ End up with a neat "Decision Maker"!

You're going to have to go there some day, so it might as well be now! Virtually all electronic designs have gone to Surface Mount Technology. SMT components are small, at time the size of a pin head, and require very special skills to assemble and solder. Besides good eyes, a magnifying glass, and a fine tip soldering iron, you will need to learn exactly how they are attached to PC boards, how they work, and how to do it!

This kit takes you through all that, including soldering, desoldering, removing, and component placement. When you're done, you have a neat electronic Decision Maker you can use! Even includes flashing SMT LEDs! Requires a 9V battery.

|        |                                      |         |
|--------|--------------------------------------|---------|
| SM200K | SMT Practical Soldering Course & Kit | \$20.95 |
|--------|--------------------------------------|---------|



### 3-In-1 Multifunction Soldering Lab

- ✓ RoHS compatible soldering station!
- ✓ Digital multimeter!
- ✓ Regulated lab power supply
- ✓ Everything all in one unit!

Anyone who has worked with electronics knows the hassle of dealing with various bulky devices needed to get the job done. This brand new 3-in-1 lab kit gives you the most commonly required tools in one amazing compact package!

Take a close look! On your left is a multi-function 3 1/2 digit digital multimeter. Its large backlit LCD display can be seen from anywhere on your bench while you're working. The DMM also features built-in transistor, diode, and continuity testing, data hold, and audible alarm.

Next up, the regulated lab DC power supply. Switch selectable ranges of 3V, 4.5V, 6V, 7.5V, 9V, and 12V provide a continuous duty current of 1.5 amps with a 2 amp peak! Features both overload protection and overload indication.

To the right we have a high quality temperature regulated soldering station. One would think there's not much to say about a soldering station but not the case here. The 24V low voltage iron features an isolated ceramic 48 watt temperature controlled element. Front panel control gives you variable tip temperature control from 150°C to 450°C (300°F to 840°F) and LED indication of power-on and heating-on. It gets even better...it is designed to maintain the temperature required for lead free soldering! If you're looking for the latest and the greatest...this is it! 120VAC.

|       |                                    |          |
|-------|------------------------------------|----------|
| LAB1U | 3-In-1 Multifunction Soldering Lab | \$119.95 |
|-------|------------------------------------|----------|



# 800-446-2295

## www.ramseykits.com

**MORE than just friendly on-line ordering!**

Clearance Specials, User Forums, Dealer Information, FAQ's, Kit Building Guides, Downloads, Live Weather, Live Webcams, and much more!

Prices, availability, and specifications are subject to change. We're not responsible for typos, mistakes, and stupid! Visit [www.ramseykits.com](http://www.ramseykits.com) for the latest pricing, specials, terms and conditions. Copyright 2006 Ramsey Electronics, LLC...so there!



**Get The New 2007 Catalog Today!**





# NEW PRODUCTS

- HARDWARE
- SOFTWARE
- GADGETS
- TOOLS

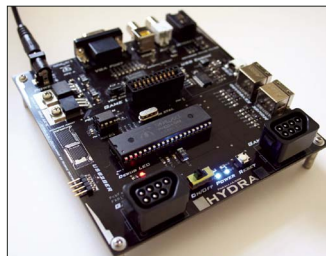
## BECOME A VIDEO GAME DEVELOPER

If you have ever thought about becoming a video game developer, now is your chance. Parallax, Inc. — a privately held company located in Rocklin, CA — has partnered with Nurve Networks LLC and Andre' LaMothe, best-selling game development author, to release a new Propeller powered gaming product, the HYDRA Game Console! With the HYDRA you can develop games, graphics, and media applications.

For beginner to intermediate coders, you need only basic programming experience in any BASIC or C-like language. All of the hardware and software you need is included. Additionally, the HYDRA hardware is covered in detail with schematics, descriptions, dozens of games, demos, and tips allowing you to take full advantage of its resources, including its expansion port and 128K game card.

The HYDRA kit also comes with *Game Programming for the Propeller Powered HYDRA*, Andre' LaMothe's latest work. This comprehensive book covers everything you need to know about game programming for the Propeller in Spin and assembly language. All aspects of the Propeller chip are introduced, from its architecture to using the Propeller Tool for programming.

The Propeller chip was released by Parallax in April 2006. The chip — designed at the transistor level — uses a new custom-silicon design for simultaneous multi-processing. The Propeller is a 32-bit architecture consisting of eight processors



which run at 3.3V up to 80 MHz. The Propeller is programmed in both a high-level language, called Spin™, and low-level (assembly)

language.

The HYDRA Game Console is available on the Parallax website or by calling the phone number listed below.

For more information, contact:  
**Parallax, Inc.**  
Tel: 888-512-1024  
Web: [www.parallax.com](http://www.parallax.com)

## EMBEDDED WEB SERVER AND 802.15.4 NETWORKING

The WPAN-GW1 from MicroAutomata Corporation is an embedded web server designed for prototyping, OEM, educational, and hobby use, particularly for IP home and building automation networks. The circuit board hardware includes a 40 MHz Microchip PIC18F6722 with 128 Kbytes of program Flash, an RS-232 port, a Microchip ENC28J60 Ethernet controller, a 2 Mbyte Atmel AT45DB161D Data Flash, a protected 5V main DC regulator, a 3.3V regulator for onboard low voltage circuits, and an additional 3.3V ultra-low noise LDO regulator and connector for an optional WPAN-RF 802.15.4 module. Adding an optional WPAN-RF

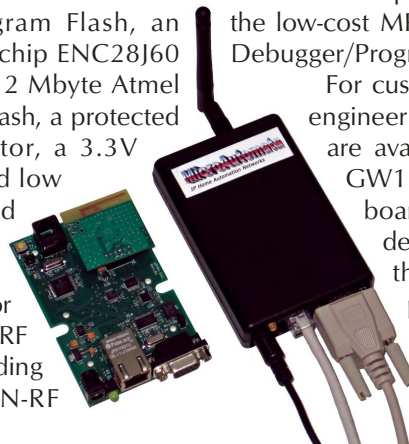
module allows the WPAN-GW1 to be used as an 802.15.4 network controller or router, as well as an Ethernet LAN and 802.15.4 WPAN Gateway.

Several 802.15.4 RF modules based on the TI/Chipcon CC2420 2.4GHz transceiver are available for evaluating different antenna topologies. The WPAN-RF1 module uses a PCB inverted-F antenna for minimum cost and size. The WPAN-RF2 module uses a PCB folded dipole antenna which provides the lowest cost solution, but a larger PCB antenna geometry. The WPAN-RF3 module uses an external antenna adding more cost but providing higher antenna gain options.

Open source, real-time operating system software solutions available with the WPAN-GW1 are FreeRTOS, as well as the OSEK/VDX based PICO18. For embedded Internet-networking, the board also supports the open source Microchip TCP/IP stack and web server with AJAX support. Support for the optional WPAN-RF modules is available with the Microchip Zigbee Stack which includes the 802.15.4 driver for the CC2420 transceiver, and the Microchip boot-loader.

Free software development tools provided by Microchip are the MPLAB IDE and MPLAB C18 student edition C compiler. Also supported is the low-cost MPLAB ICD 2 In-Circuit Debugger/Programmer.

For custom hardware design, engineering design packages are available for the WPAN-GW1 and WPAN-RF circuit boards. Each engineering design package includes the CadSoft Eagle project with schematic file, PCB file, manufacturing files, parts library, and a



hardware design and theory of operation manual. Designs are compatible with the low-cost CadSoft Eagle standard and academic versions.

The WPAN-GW1 is available as a stand-alone circuit board for \$89 or as a complete kit with enclosure, universal power supply, and communication cables for \$119. The WPAN-GW1 engineering design package will be available for \$49. The WPAN-RF1 and WPAN-RF2 modules will be available for \$29. The WPAN-RF3 module will be available for \$39. Each WPAN-RF module engineering design package will be available for \$39.

For more information, contact:

**MicroAutomata  
Corporation**

Tel: 256-513-4775

Email: [sales@microautomata.com](mailto:sales@microautomata.com)

Web: [www.microautomata.com](http://www.microautomata.com)

## NEW DUAL TRACE ANALOG SCOPES



**T**wo new value-added, 20 MHz and 30 MHz dual trace analog scopes — one featuring a component tester and the other alternate magnification — are now available from Protek Test & Measurement, a division of Intelient Technologies, Inc.

Equipped with a high brightness CRT, the 30 MHz bandwidth Model 6030C has a built-in component tester which tests inductors, capacitors, and diodes via a characteristics waveform displayed on the screen. This capability is push-button activated. In addition, the instrument features Alternate Trigger for display stability, 1 mV sensitivity vertical input, and X10

magnification in horizontal sweep, trigger signal output and TV synch filter are also standard.

The Model 6030C is priced at \$484 MSRP, complete with probes, test leads, line cord, and operating manual.

The 20 MHz bandwidth Model 6020 features Alt-Mag sweep for the simultaneous display of the main and X10 magnified waveform. This lightweight, low power (40W) entry also provides Alternate Trigger and Auto

Trigger for stable displays, X10 horizontal magnification, Z axis modulation, along with a high brightness 8x10 cm CRT with internal graticule.

The Model 6020 is offered complete with all test probes and manual for \$449 MSRP.

For more information, contact:

**Protek Test &  
Measurement**

Web: [www.protektest.com](http://www.protektest.com)

## The Mouser Advantage: Faster Time to Market for YOUR New Designs!



Experience Mouser's time-to-market advantage! Our vast selection of the NEWEST products, NEWEST technologies, **new catalog every 90 days**, no minimums, and same-day shipping on most orders, gets you to market faster. We make it easy to do business with Mouser!

**mouser.com (800) 346-6873**



a tti company

**The Newest Products  
For Your Newest Designs**

The NEWEST Semiconductors | Passives | Interconnects | Power | Electromechanical | Test, Tools & Supplies from Mouser Electronics

Mouser and Mouser Electronics are registered trademarks of Mouser Electronics, Inc. Other products, logos, and company names mentioned herein, may be trademarks of their respective owners.



## SEW DIGITAL MILLIOHM TESTER



**H**oyt Electrical Instrument Works now offers the SEW Digital

Milliohm Tester's, 4136mO & 4137mO. The 4136mO has a power source of 110 VAC or 230 VAC and the 4137mO of 12 VDC. These testers are for measuring low ohms to detect any high potential lead junction resistance in compression or solder joints. It can be used by manufacturers, maintenance, engineers and anyone else trying to analyze if there is resistance where there shouldn't be.

Both of these lightweight, robust, and compact Milliohm Testers feature

four terminal measurements, three test current with over-temperature protection, protection against inadvertent connection to over-voltage, large LCD, potential lead resistance, current lead resistance checks, a future optional rechargeable battery, and an O-Ring sealed case. Both include full-featured EnerSave™ inside with EnerSave AUTO-HOLD and AUTO-OFF. They measure down to 100  $\mu\Omega$ , five ranges from 200.0 m $\Omega$  to 2000  $\Omega$ , and have a minimum resolution of 100  $\mu\Omega$ .

Price is \$455; in stock now.

For more information, contact:  
**Hoyt Electrical Instrument Works, Inc.**  
23 Meter St.

Penacook, NH 03303

Tel: 603-753-6321

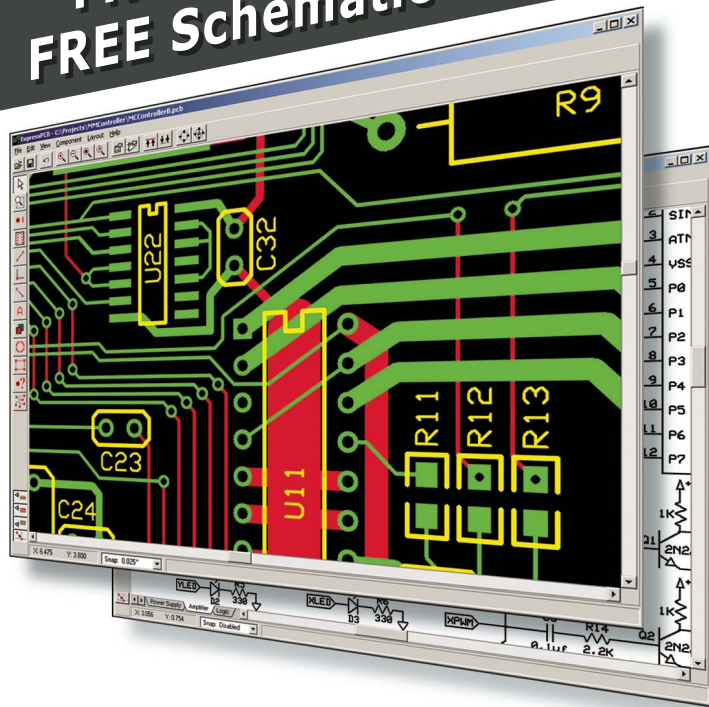
Fax: 603-753-9592

Email: [info@hoytmeter.com](mailto:info@hoytmeter.com)

Web: [www.hoytmeter.com](http://www.hoytmeter.com)

# \$51<sup>For 3</sup> PCBs

## FREE Layout Software! FREE Schematic Software!

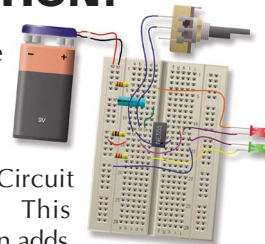


- 01 DOWNLOAD our free CAD software
- 02 DESIGN your two or four layer PC board
- 03 SEND us your design with just a click
- 04 RECEIVE top quality boards in just days

**expresspcb.com**

## CIRCUIT WIZARD NOW INCLUDES BREADBOARD SIMULATION!

**N**ew Wave Concepts of Cambridge, UK, announces the release of Circuit Wizard v1.1. This improved version adds a whole host of new features including PCB current flow animation, quality checking for identifying PCB faults, and subsystem modelling. Circuit Wizard v1.1 also includes breadboard simulation, which allows users to select from a wide range of different breadboards and then add components and hook-up test instruments. Circuit Wizard's breadboards are ideal for learning about the real things and make it quick and easy to prototype project ideas.



For more information, contact:  
**New Wave Concepts**  
Tel: 800-535-8469

Email: [armand@kelvin.com](mailto:armand@kelvin.com)

Web: [www.kelvin.com](http://www.kelvin.com)



# R8C/Tiny Brings 16-bit Performance to 8-bit Applications

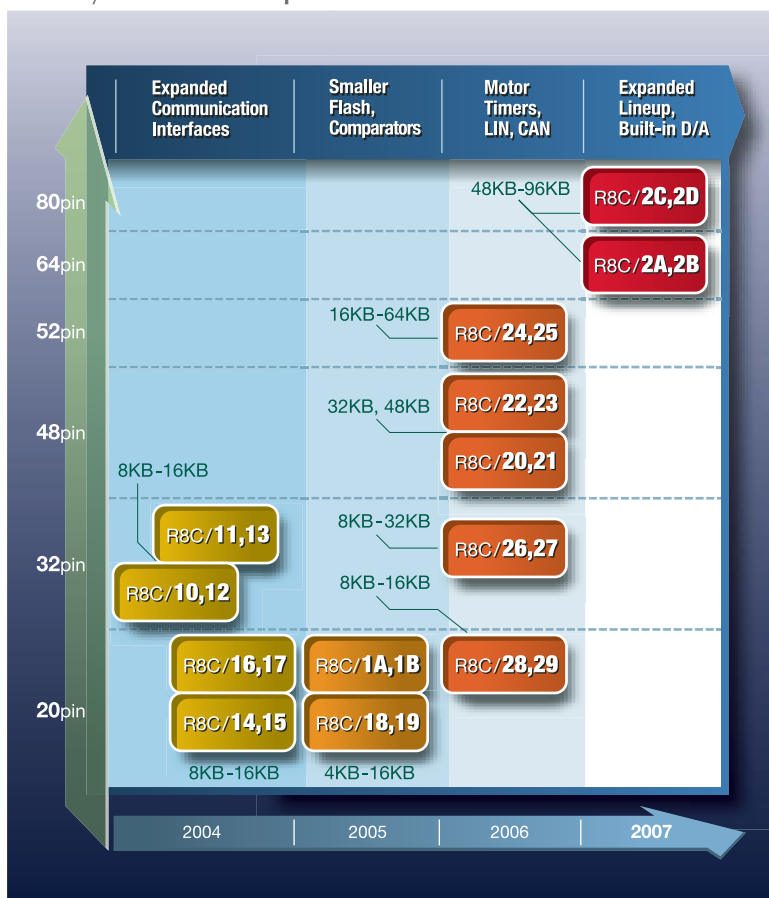
High-performance: 40MHz on-chip oscillator and single-cycle flash memory access

## Renesas Technology

No.1\* supplier of microcontrollers in the world

introduces the R8C/Tiny Series of microcontrollers. Its powerful 16-bit CPU core running at 20MHz provides the performance never imagined in 8-bit MCUs. R8C/Tiny MCUs high level of integration and peripheral set will enhance your application's functionality while reducing the overall system cost.

### R8C/Tiny Product Roadmap



\*Source: Gartner Dataquest (April 2006) "2005 Worldwide Microcontroller Vendor Revenue" GJ06333

HOT Products

R8C/25

| R8C/Tiny CPU                                      | Program Flash<br>(16KB - 64KB)         | RAM<br>(1KB - 3KB)                |
|---|--|-----------------------------------|
| Oscillation Circuit<br>Main Clock<br>(20MHz Max.) | Data Flash<br>(2KB)                    | Power-On Reset<br>Circuit         |
| On-chip Oscillators<br>(40MHz, 125KHz)            | Low Voltage<br>Detect Circuit          | Protect Register                  |
| Oscillation Circuit<br>Sub Clock<br>(32KHz Clock) | Enhanced WDT                           | 16-bit motor<br>control Timer (2) |
| RTC   | External Oscillation<br>Stop Detection | 8-bit Timer (3)                   |
| Serial I/O<br>Clock Sync./ UART<br>(2ch)          | SSU/I2C                                | A-D Converter<br>(10-bit x 12ch)  |
| 44 GPIO   | Hardware LIN                           | On-Chip Debug                     |

Package: 52pin LQFP (10mm x 10mm, 0.65mm pitch)

### Top Reasons To Select R8C/Tiny

- **High-Performance**
  - 16-bit CPU runs at 20MHz, executing instructions in as fast as 50nsec.
- **Scalable**
  - Same core, same peripherals allows easy portability from 20 to 80pins
- **High-Integration**
  - Includes 40MHz on-chip oscillator, data flash, power-on reset circuits, several 8- and 16-bit timers, up to 20 channels of A/D, D/A, LIN, CAN and more
- **Reliable**
  - Oscillator stop detection circuits, access control of system registers
  - Watchdog timer with on-chip oscillator, programmable low-voltage detect circuit
- **World-class Development Environment**
  - Complete software and hardware tools for short development cycle
  - Free 64KB software tool chain



## Get Started Today -

Go online and register to be eligible for a FREE Starter Kit

[www.america.renesas.com/ReachR8C/e](http://www.america.renesas.com/ReachR8C/e)



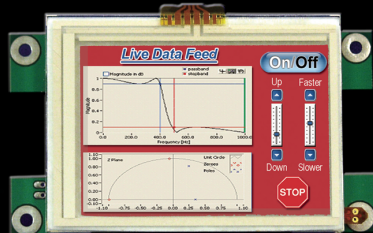
Renesas Technology Corp.

Everywhere you imagine. **RENESAS**



# SHOWCASE

## Instant LCD



A TFT LCD GUI in your project next week!  
From \$199 - 2.7" & 5.6" Interfaces to Any Micro  
serial - i2c - SPI - flash images & fonts - touch

**ezLCD.com**

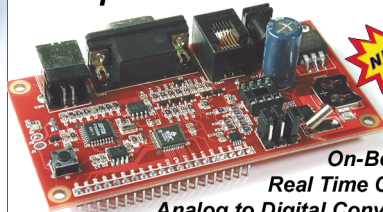
## CASH BUYERS OF ELECTRONIC EXCESS

**GREENCHIP**

**CALL 1-888-GRN-CHIP**  
416-244-7  
or visit:  
**www.greenchiponline.com**

**Celebrating  
10 Years  
in Business**

## STAMP STACK 2P "Experimenters Board"



**NEW!**

On-Board:  
Real Time Clock  
Analog to Digital Converter  
USB and RS-232 Programmable  
**Basic Stamp 2P24 Compatible**

**www.HWTECH.com**

**(403) 730-8603**



5mm White  
water clear  
**LED 3.5V**  
10,000 mcd  
(AB287)  
**\$0.56**

**20 second voice recorder/playback module.**  
(pre-assembled) (A96010) **\$6.60**

The Velleman Personal Scope  
is a complete 10MS/s portable  
oscilloscope. (HPS10) **\$129.**

**Electronics123.com**  
Tel: 1-888-549-3749

102 E. Park Ave, Columbiana OH 44408

**Thousands  
more items on  
our web site!**

## LITEXPO™ Digital Video Player Board



(monitor not included)



### Build your own E-FRAME

- Ideal for portable slide show & presentation
- Plays MPEG 1, 2, 4 video, JPEG image & MP3 on TV or any regular video monitor
- USB communication interface
- CF card, A/V output port & remote control feature optional

**\$79**

Tel: (847) 202-0010 **www.LITEXPO.com**

## Affordable Powerful Portable USB Lab Instruments

**Oscilloscope**  
Dual Channel, 20MS/s  
Hardware Preamp  
Advanced Triggering  
**\$199 USD**

**Waveform Generator**  
0.1Hz to 100kHz  
Preprogrammed and  
Arbitrary Waveforms  
**\$139 USD**



PC • Linux • Mac  
Open Source Software

**www.syscompdesign.com**



## www.Primecell.com

### Battery rebuilding service

Dead Batteries? Don't toss them.  
Send them to us - our rebuilds are  
better than original specifications.



**Tools**  
Hilti Skill  
Milwaukee  
Panasonic  
B&D DeWalt  
Makita All  
2-36 Volts

**Electronics**  
Bar Code  
Scanners  
Surveying  
Printers  
Laptops  
Photography



**Radios**  
APELCO  
UNIDEN  
G.E. ICOM  
KENWOOD  
MOTOROLA  
MIDLAND  
MAXON  
YAesu  
ALINCO

Visit **www.primecell.com** for important details  
24 Hr Secure recorder tel-fax (814) 623 7000  
Quotes email: **info@primecell.com**  
Cunard Assoc. Inc. 9343 US RT 220 Bedford PA 15522

## PRINTED CIRCUIT BOARDS

**QUALITY PRODUCT  
FAST DELIVERY  
COMPETITIVE PRICING**

- \* Aluminum Backed PCB
- \* Single & Double sided
- \* SMOBC/RoHS
- \* LPI mask
- \* Through hole or SMT
- \* Nickel & Gold Plating
- \* Routing or scoring
- \* Electrical Testing
- \* Artwork or CAD data
- \* Fast quotes
- \* Flex Circuits

**10 pcs (3 days)  
1 or 2 layers \$249  
10 pcs (5 days)  
4 layers \$695**

(up to 30 sq. in. ea.)  
includes tooling, artwork,  
LPI mask & legend

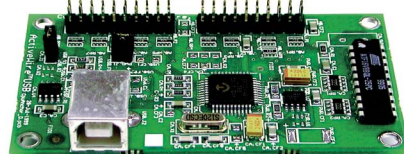
**PROTOTYPE THROUGH  
PRODUCTION  
PULSAR, INC**

9901 W. Pacific Ave.  
Franklin Park, IL 60131  
Phone 847.233.0012  
Fax 847.233.0013

**We will beat any  
competitor's prices!!!**

**www.pulsar-inc.com • sales@pulsar-inc.com**

## ActiveWire® USB Simple USB Interface!



- Works with MacOS 8/9, Win98/2K/ME/XP  
FreeBSD and Linux!
- 24Mhz CPU core with USB
- Firmware downloadable via USB
- 16 bit parallel Input/Output
- See web-site for add-on boards
- All drivers, manuals, demos are on our  
web-site for immediate download!

**\$59**  
plus shipping

**ActiveWire, Inc.**  
**www.activewireinc.com**

ph +1.650.465.4000 fax +1.209.391.5060

## 10 Year Olds Can Now Hand Solder ANY Surface Mount Component - Even BGA



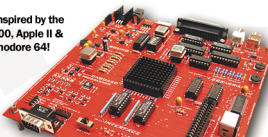
**AND SO CAN YOU!**

**www.schmartboard.com**

## ANDRE LAMOTHE'S XGAMESTATION

LEARN STEP-BY-STEP HOW TO BUILD  
AND DESIGN YOUR OWN VIDEO GAME CONSOLE!

Design inspired by the  
Atari 2600, Apple II &  
Commodore 64!



### INCLUDES:

- Great for Hobbyists AND Students!
- The Fun Way to Learn Embedded Systems!
- Fully Assembled XGS Micro Edition Unit!
- Complete Software Development Kit!
- Tools, Demos & Utilities!
- eBook on Designing the XGS Console!
- Cables and Power Supply Included!

Powered by the Ubicom  
**SX52 @ 80 MIPS** and  
Parallax **SX-Key** Compatible!



**WWW.XGAMESTATION.COM**  
(925) 736-2098 SUPPORT@NURVE.NET

## QKITS.COM

### USB OSCILLOSCOPE

- Inputs: 2 channels,  
1 external trigger input
- Input impedance:  
1 Mohm/ 30pF
- Bandwidth: DC to  
60 MHz ±3dB
- Record length: 4K  
samples/channel
- Real time sampling  
frequency: 1.25 kHz to 50 MHz
- Sampling frequency for Repetitive signals: 1 GHz
- 2 x 60 MHz scope probe & USB cable  
included.

**\$329.95**  
+ free tool bag!

**1-888-GO 4 KITS**  
**GREAT PRICES, GREAT SHIPPING RATES**



## POTENTIOMETER TO KEYSTROKE CONVERTER



- CONVERT POTENTIOMETER MOVEMENT INTO KEYSTROKES
- 6 PROGRAMMABLE CHANNELS
- EMULATES USB KEYBOARD

**888-690-9080**  
HAGSTROMELECTRONICS.COM  
11 FIDDLERS GREEN, LANSING NY 14882

## What's New In The Forums?

If you haven't been to the *Nuts & Volts* forums lately, you've likely missed out on a lot of great discussions. There are over **4,000 registered users** and over **40,000 posts** covering every electronics topic imaginable.

Here are some recent topics that have been in discussion.

- Car Tachometer Interface
- Using A Light Dimmer On LEDs
- Testing Car Battery Draw
- Reversing Motors
- Drill Bit Sharpening
- 4050 Non Inverting Hex Buffer
- Monitoring Specific Gravity
- Christmas Light Fun

Current forums include:

**General Electronics**  
**Discussion**  
**Computers**  
**Robotics**  
**Programming**

**New ➤ Up For Grabs**

Check out the new forum **Up For Grabs**. It's the place to **post any electronics items for sale, trade, or to give away to a good home**. It's for *private party (personal) items only*. No commercial vendors allowed. Oh yeah, and **it's FREE**.

So, don't throw out that junk you're not using — it may be just what a budding electronics hobbyist needs to get that project finished!

*Check it out for yourself today!*

**www.nutsvolts.com**

## GADGET GEEKS GET THEIR OWN SEARCH ENGINE

**R**etrevo ([www.retrevo.com](http://www.retrevo.com)) is the first dedicated search engine specifically for gadget geeks to research consumer electronics, check community buzz, find pre-purchase information, and get product documentation for technical support and troubleshooting.

Using Retrevo, gadget lovers will find complete coverage for 12 categories, including cell phones, smartphones, cameras, camcorders, home audio and home video, portable audio and portable video, printers, and wireless networking (WiFi).

"We all hear about the latest and greatest gadgets, but with so many cool new toys, it's impossible to get good information to buy the right product and make it work with the ones we already have," said Vipin Jain, CEO, Retrevo. "And when it comes to product documentation — forget it." "Retrevo has already searched all the manufacturers' sites so you don't have to."

Retrevo uses proprietary algorithms to crawl, collect, analyze, and classify all known information for consumer electronics products. The company's machine learning technology performs deep content analysis, classification and retrieval, so you get the right answers right away.

"Every geek knows information is king," said Charles Wilson, VP Marketing, Retrevo. "As gadget geeks ourselves, we set out to create a comprehensive consumer electronics research site that would address the full lifecycle of the products we buy, install, connect to other devices, and ultimately fix or replace."

## IEEE SETS NEW ETHERNET SPEED

**T**he next Ethernet speed will be 100 Gbps, the IEEE (Institute of Electrical and Electronics Engineers) voted recently. Now the standards body just has to go build something never done before.

The IEEE's High Speed Study Group (HSSG), tasked with exploring what Ethernet's next speed might be, voted to pursue 100G Ethernet over other considerations, such as 40 Gbps Ethernet. The IEEE will work to stan-

dardize 100G Ethernet over distances as far as six miles over single-mode fiber optic cabling and 328 feet over multimode fiber.

With the approval to move to 100G Ethernet, the next step is to form a 100G Ethernet Task Force to study how to achieve a standard that is technically feasible and economically viable, says John D'Ambrosia, chair of the IEEE HSSG, and scientist of components technology at Force10 Networks.

"There is still a lot of work to be done to finalize our objectives, and where this thing will go," D'Ambrosia says, adding that a formal task force could be approved by July 2007. A completed 100G Ethernet standard might appear by 2009 or 2010. "The next step is getting the project into the 802 process," he adds, referring to the IEEE's umbrella of Working Groups for networking standards, which govern everything from wired Ethernet and Token Ring to wireless LANs and WiMAX.

The need for 100G Ethernet is growing as IP video and transaction-intensive Web 2.0 applications are exploding across the Internet. Companies such as YouTube regularly add 10 Gbps service pipes to meet growing demand, and carriers will need a better way to aggregate such links, industry watchers say.

The challenge for 100G will be to push Ethernet to a megabits-per-second speed that does not currently exist under any standard. Examples of past leaps in Ethernet speeds, which followed the lead of other technologies include: Fast Ethernet, followed the 100 Mbps FDDI standard; and 10G Ethernet, which used the 9.9 Gbps OC-192 SONET as its base. In each case, resulting Ethernet standards borrowed components and encoding techniques used in the existing non-Ethernet standards.

While a comparable 100 Mbps standard does not exist now for Ethernet to emulate, D'Ambrosia anticipates this will not be too great a challenge for work on 100G. A 100G standard will probably use parallel data

*Continued on Page 71*





## ■ THIS MONTH'S PROJECTS

Control Your World — Part 4 . . .34

Battery Charger Switcher . . . .40

Macro Photography Ring Flash . .46

## ■ LEVEL RATING SYSTEM

*To find out the level of difficulty for each of these projects, turn to our ratings for the answers.*

●●●● . . . . Beginner Level

●●●● . . . . Intermediate Level

●●●● . . . . Advanced Level

●●●● . . . . Professional Level

**I am always on the lookout for ways to make exercising more fun.**

**A while back, I was searching for an exercise bike that had a steering wheel and would let me hook it up to my PC so I could play my favorite racing games and exercise at the same time. There are a few systems on the Net, but they are outrageously expensive and only work on console systems.**

# CONTROL YOUR WORLD

## PART 4 — Build a Gaming Exercise Bicycle

**I**n this installment of Control Your World, I am going to show you how simple it is to use a microcontroller in this quest for control. While the project may look very complicated, it has been presented in such a way that anyone with even the slightest soldering skills should be able to complete the project.

### Components Needed for the Project

#### Steering Wheel

The first and most important item you will need is a steering wheel controller used to connect to your PC.

I started digging through my attic and found a Microsoft Sidewinder steering wheel shown in Figure 1. I don't think Microsoft manufactures these any more, but you can pick one up online new or used.

Please note before we move on that just about any wheel and pedal set will work. You will have to make adjustments accordingly, and I will show you the areas that will need special attention if you decide to

use another wheel and pedal set.

#### Encoder

In order to gather speed and direction information from the exercise bike, we need to use a rotary encoder, sometimes called a quadrature encoder. We will be using the CT3002 shown in Figure 2. These are available for under \$3 from Digi-Key.

#### Microcontroller Interface

In order to read the encoder and send the data to the steering wheel, we need to use a microcontroller. For this project, we will be using the DiosPro microcontroller available from Kronos Robotics ([www.kronosrobotics.com](http://www.kronosrobotics.com)). We will be using a 40-pin version of the DiosPro shown in Figure 3.

#### Digital Potentiometer

To interface to the steering wheel, we need to simulate two pedals. The two pedals are actually two potentiometers. We will be using a Microchip MCP42010 to replace the two potentiometers used by these pedals.

The 010 in the part number indicates that the digital potentiometers are 10K. If you are using some other steering wheel, you will need to determine the values of the potentiometers in the pedals.



■ FIGURE 1



■ FIGURE 2

Microchip makes 10K, 50K, and 100K digital pots. You will need to purchase the chip that best matches your pedals.

### Other Components

We will be using a Dios Workboard Basic shown in Figure 5 as our electronic building platform. It has everything we need to program the DiosPro and power our circuit. It has a very large prototype area that is indexed so I can give step-by-step instructions for all the connections necessary to build this project. If you use this board, the level of difficulty for this project is 1. Without the board, it is a 3 or 4.

## 10,000 Foot Overview

Before I jump into construction, let me give you a high-level overview of the project.

An encoder is mounted on your exercise bike. This encoder is connected to a Dios microcontroller. The Dios determines the speed and direction the encoder is going and sets the values of the two digital potentiometers in the MCP chip via an SPI interface.

The digital potentiometers are then connected to the pedal interface on your steering wheel. The steering wheel is connected to your PC just as it normally would be.

As you play your favorite game, pedaling forward is the same as hitting the accelerator. The faster you pedal, the faster you go. When you pedal back-

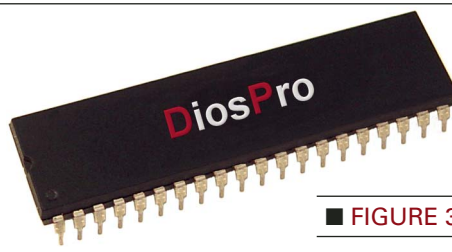


FIGURE 3

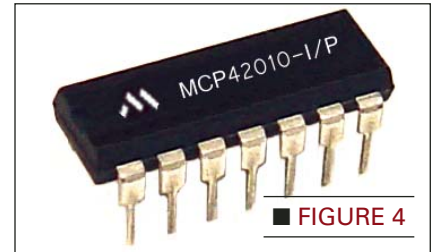


FIGURE 4

wards, you basically put on the brakes or go backwards, depending on the game.

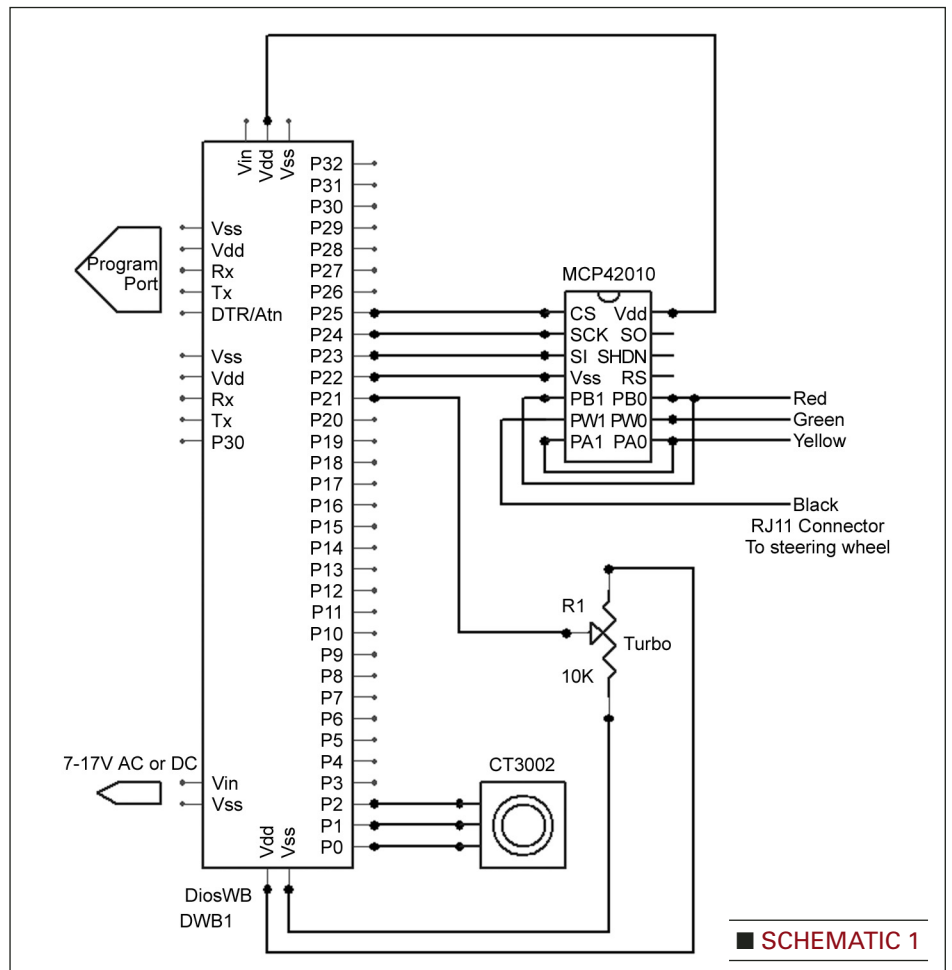
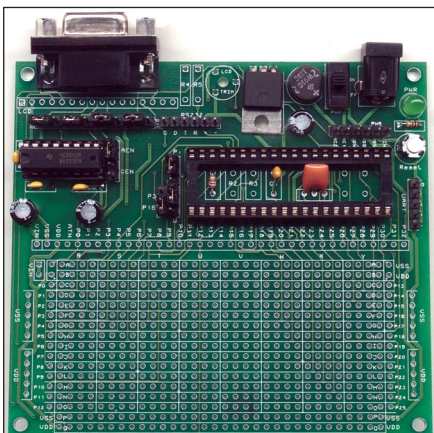
## Construction

Let's start by taking a look at Schematic 1. The main component labeled DiosWB is the Dios Workboard. All the connections indicated are labeled on the board. The Workboard has a built-in RS-232 driver that only requires a nine pin cable in order to program the Dios. It also has a bridge

rectifier and regulator on board so it will accept both AC and DC for input power. The MCP is connected to the Dios via an SPI interface. The MCP digital potentiometers are then connected to the steering wheel using an RJ11 jack.

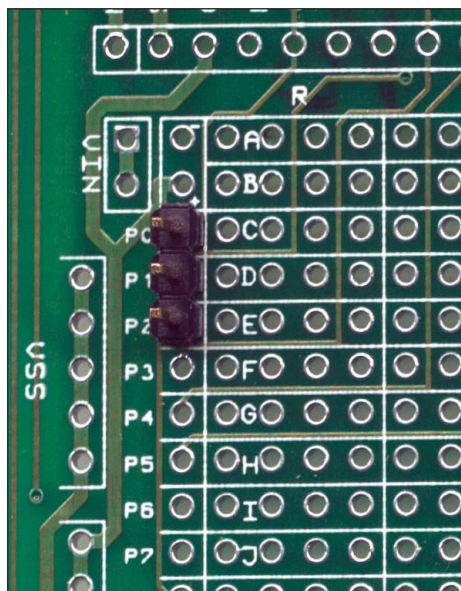
The encoder is connected to ports 0 and 2. Port 1 is set as an output and driven low to provide Vss to the center terminal of the encoder. Normally, we would need to hold ports 0 and 2 high with pull-up resistors, but the Dios has the ability

FIGURE 5



SCHEMATIC 1



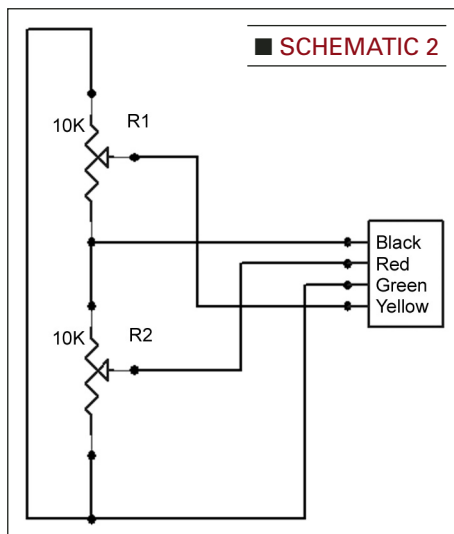


■ FIGURE 6

to apply internal pull-ups to ports 0-7.

Notice that we have added potentiometer R1. The wiper is connected to port 21 which we will configure as a 10-bit A/D input port. By connecting the two other leads to Vss and Vdd, we can monitor the setting of the pot and use it to create a multiplier. Think of this as a turbo boost. When set to minimum, the multiplier is set to 1. When set to max, the speed you are pedaling will be multiplied by 32.

The Sidewinder pedals are wired as shown in Schematic 2. The MCP must be wired the same way. If you are using a game controller other than the Sidewinder, you will need to determine the wiring hookup. In most cases, you have to open up the pedal section to determine this. Once you determine the wiring, you can also determine the



value of the potentiometers used.

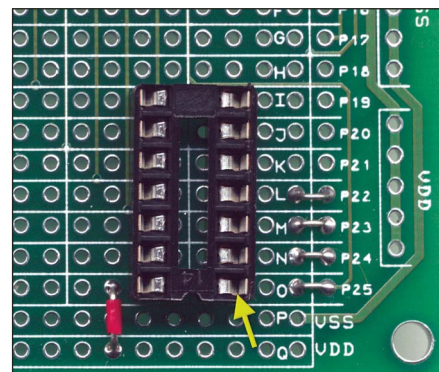
## By the Numbers

If the main schematic looks complicated, don't worry; these step-by-step instructions will walk you through the construction.

Let's start with the main board.

- **Step 1:** You need to assemble the Workboard now. It comes with its own step-by-step assembly instructions. When completed, it should look like the board in Figure 5. Notice the large prototype area at the bottom of the board. This is where we will do the remainder of the assembly as we proceed.

- **Step 2:** Break off a three-pin section from the 40-pin header. You can use wire cutters to make the job easier. You will notice on the right and left side of the prototype area on the Dios



■ FIGURE 7

Workboard are the markings P0-P25. These are connected directly to the Dios chips I/O ports. In this step, we are going to insert the three-pin header section into the ports marked 0-2 as shown in Figure 6. Hold the header in place and solder on the underside of the board.

- **Step 3:** The Workboard prototype area has pad markings A-Q along the sides and R-Y along the top. These markings are explained in the Workboard manual.

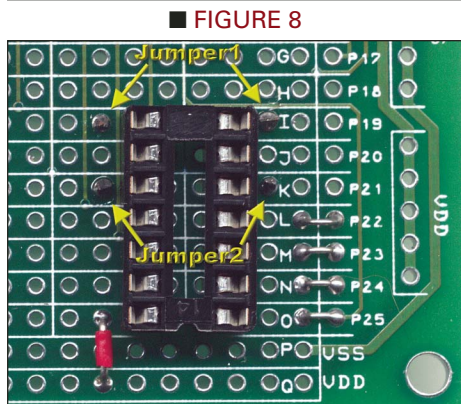
As you place the jumpers, solder each one on the underside of the board.

Using the pad markings, place a jumper from XO2 to VDD as shown by the red jumper in Figure 7. Make the following connections: YL4 to P22, YM4 to P23, YN4 to P24, and YO4 to P25 as shown in Figure 7.

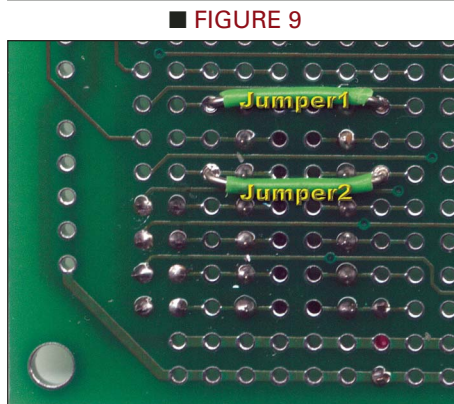
Take your 14-pin socket and solder it into the position shown in Figure 7. Note that pin 1 of the socket (marked by the arrow) is located on pad YO2.

These connections connect the MCP chip to the Dios chip. We are supplying Vss to the MCP via port 22 of the Dios when we pull the port low.

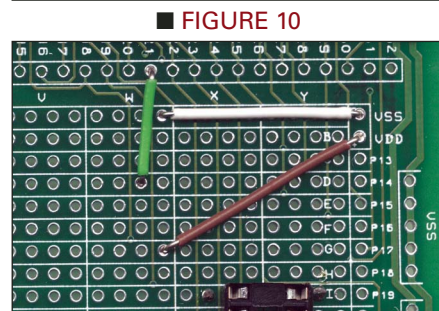
- **Step 4:** We need to connect two



■ FIGURE 8

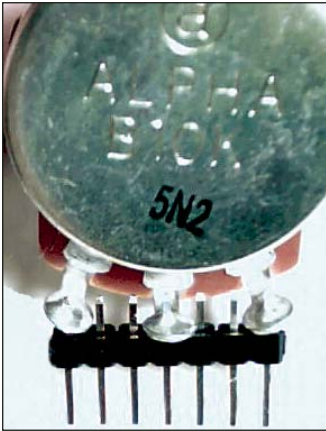


■ FIGURE 9

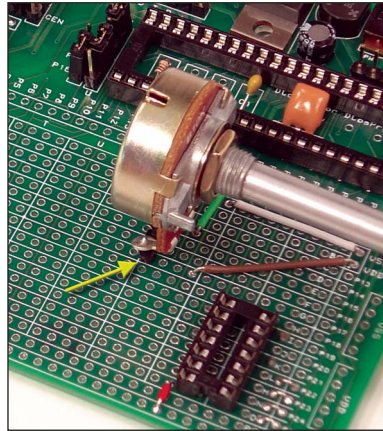


■ FIGURE 10

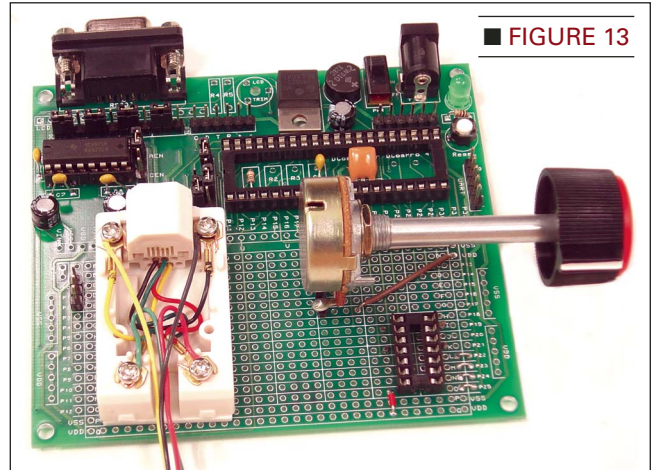




■ FIGURE 11



■ FIGURE 12



■ FIGURE 13

jumpers: one from X12 to Y13 and the other from XK2 to YK3 as shown in Figure 8. The easiest way to do this is from the underside of the board (see Figure 9). Note that these jumpers are specific to the Sidewinder joystick.

• **Step 5:** For the turbo potentiometer, you need to make the following connections: HD3 to P21, HA4 to Vss, and HG4 to Vdd as shown in Figure 10.

• **Step 6:** In order to connect the turbo potentiometer, you need to solder a header to the potentiometer leads. The turbo potentiometer is a 10K linear-taper. Break off a seven-pin header. Insert the short end into the potentiometer leads and solder in place as shown in Figure 11. Note that only the ends and center pins on the header are used.

Insert the header into the pads shown in Figure 12. The end pins are inserted into pad HA1 and HG1. The center pin is inserted into pad HD1. Solder the pins on the underside of the board and cut off the excess.

• **Step 7:** You will need about 5" of four conductor telephone wire. Remove the wires and strip about 1/4" off each end. Attach one end of each colored wire to the corresponding color

on the RJ11 jack. Use some double-stick tape to attach the jack to the board as shown. The jack I used came with a self-stick pad, shown in Figure 13.

Make sure you situate the jack so that it can be accessed once attached.

• **Step 8:** Connect the four wires as follows: Red = YK4, Green = XJ1, Black = YJ4, and Yellow = YI4. Slip the RJ11 jack cover in place as shown in Figure 14. Insert the Dios chip into the 40-pin socket. The notch should be facing left. Insert the MCP chip into the 14-pin socket. The notch should be facing down.

The board is now complete. If you wish, you can attach a knob to the turbo potentiometer.

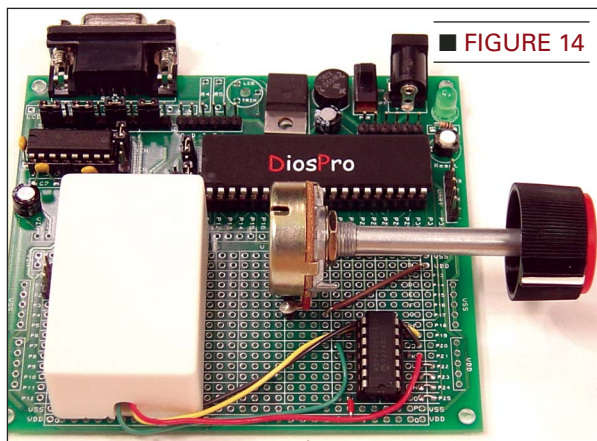
• **Step 9:** We need to attach a header to the encoder. This header will allow us to create a removable cable. Cut a five-pin header from your header stock and attach it to the encoder as shown in Figure 15. Only the outside and cen-

ter pins are used. Use some needle nose pliers to remove the unused pins.

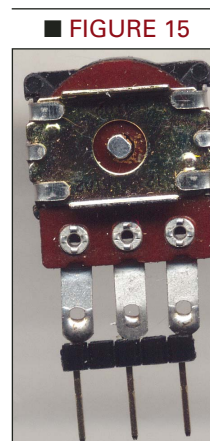
Take a strip of Plexiglas, compressed PVC, or wood about 1" x 4" x 1/8" and attach the encoder as shown in Figure 16. Take the wheel and drill a 1/4" hole through the center and slip it over the shaft of the encoder as shown. If it's not a tight fit, you can take a pair of pliers and indent the shaft.

I list a wheel in the Parts List, but you may find that another wheel works better. I have used R/C aircraft wheels with success.

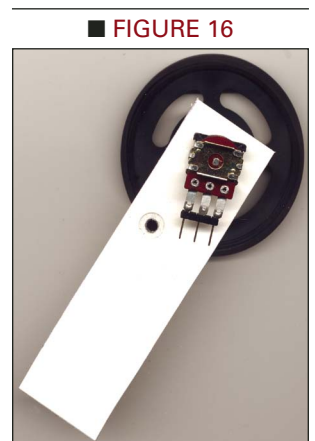
• **Step 10:** Each and every exercise bike is different, but I have three and the attachment is similar on all of them. Using double stick tape, attach the encoder assembly to the bike in such a way that the main drive wheel or pulley causes the wheel on the encoder to rotate. If your bike has a clutch that allows the fly wheel to spin when the pedals are stopped, you will



■ FIGURE 14



■ FIGURE 15

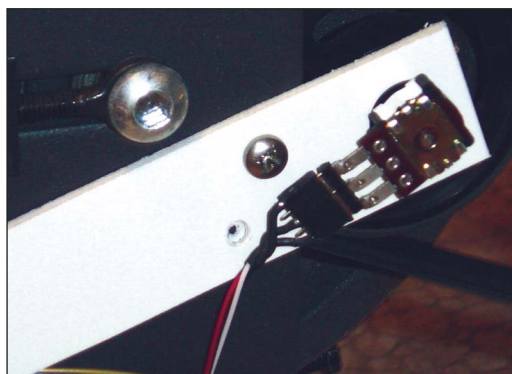


■ FIGURE 16

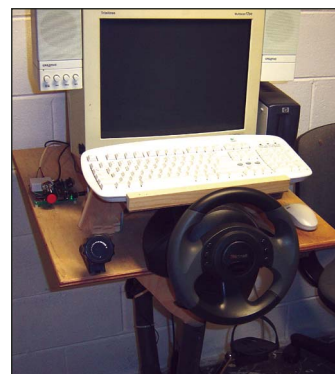




■ FIGURE 17



■ FIGURE 18



■ FIGURE 19

need to attach it to the encoder so that it comes in contact with the drive side connected to the pedals.

Notice that I used a machine screw to attach my encoder. This involves a bit more work, but the connection is more permanent.

- **Step 11:** Take about 7' of the telephone cable and strip 1/4" off the ends of three of the wires. Cut a five-pin section from the female header and attach the three stripped leads to the two outside pins and center pin as shown in Figure 18. I recommend slip-

ping a small piece of heat shrink over the wires before attaching. While this is not necessary, it will make the connections stronger and less prone to failure.

Run the cable along the frame of the bike until you get to a location where you want to mount the Workboard and cut the excess cable. Strip the ends of the three wires corresponding to the other end of the cable. Attach these to a three-pin female header. Make sure the center lead is the same as the center lead attached to the center lead on the encoder. Again, I recommend using heat shrink on the three connections.

Slip this end of the cable on the three-pin header attached to ports 0-3 back in Step 2.

- **Step 12:** Probably the largest challenge in this project is how to mount the steering wheel to your bike. Again, every bike is different. The bike shown in Figure 19 is a complete rebuild of an upright bike that I converted to a recumbent bike. I removed the original handle bars and replaced them with a table, where I mounted a complete dedicated computer system

that I got off eBay for \$50.

Steering wheel controllers were designed to mount on a table, so the best system for mounting one on an exercise bike is to mount a small board on the handle bar, then mount the wheel on that board. On my first bike, I mounted a single 2' x 1' board on the handles. I had enough room to sit a laptop on it and had a completely contained system.

Sears sells a couple of bikes by WESLO. The recumbent version would be a perfect candidate. At \$149, it is probably the best value, and it has a handle bar configuration that would be very easy to mount a steering wheel to. I prefer the recumbent bikes for a project like this as they are much more comfortable.

Note that with most bikes you will need to remove or relocate the built-in computer. I no longer use the original computer on the WESLO bikes, but it was great for getting an idea on how far or what kind of calories I was burning for each race.

## Testing the System

**First Test:** I have included a program called EBikeTest.txt. Use the Free Dios Compiler (refer to the parts list) and this code to program the DiosPro chip. The program will start to spit out two numbers. The first is the number of units the pedals have moved in the last 200 ms.

When you move the pedals forward, the value will be negative. When moving backwards, the value is positive. If this doesn't happen, simply pull the encoder cable off the three-pin header and flip it over. This will reverse

| ITEM  | PART NO.        | SUPPLIER        |
|---|-----------------|-----------------|
| <input type="checkbox"/> 10K Linear-Taper Potentiometer   | 271-1715        | RadioShack      |
| <input type="checkbox"/> One-Inch Control Knob  | 274-433         | RadioShack      |
| <input type="checkbox"/> Four-Conductor Telephone Cable 50'   | 278-0872        | RadioShack      |
| <input type="checkbox"/> Quadrature Encoder   | CT3002-ND       | Digi-Key        |
| <input type="checkbox"/> 10K Digital Potentiometer  | MCP42010-I/P-ND | Digi-Key        |
| <input type="checkbox"/> DiosPro  | 16429           | Kronos Robotics |
| <input type="checkbox"/> Dios Workboard Basic   | 16453           | Kronos Robotics |
| <input type="checkbox"/> 40-pin Male Header   | 16290           | Kronos Robotics |
| <input type="checkbox"/> 14-pin Socket  | 16279           | Kronos Robotics |
| <input type="checkbox"/> 36-pin Female Header   | 16291           | Kronos Robotics |
| <input type="checkbox"/> Plastic Wheel  | 16512           | Kronos Robotics |
| <input type="checkbox"/> Heat Shrink  | 16287           | Kronos Robotics |
| <input type="checkbox"/> AC Adapter   | 16500           | Kronos Robotics |
| <input type="checkbox"/> Nine-pin Cable   | 16259           | Kronos Robotics |
| <input type="checkbox"/> Dios Compiler (Free): <a href="http://www.kronosrobotics.com/downloads/DiosSetup.exe">www.kronosrobotics.com/downloads/DiosSetup.exe</a> |                 |                 |

### OTHER

☐ Surface Mount RJ100 Jack — This can be found at most home centers. The smaller, the better. The one I used was a RCA #TP266WH purchased at Home Depot.

☐ Tie Wraps — These can be purchased from various sources. Many home centers, as well as RadioShack sell them.

☐ Double-Stick Tape — This can be purchased at just about any department store.

the direction. Notice that the faster you pedal, the higher the number.

The second number is the multiplier which is controlled by the turbo adjust. These two numbers are used to set the MCP chip. If you are not getting the indicated readings, you will need to go back and check your connections.

**Final Test:** Program the DiosPro chip with the program called EBike.txt. Make sure the Workboard is powered up, then plug in the RJ11 cable connecting the Workboard to the steering wheel.

In Windows XP, the Sidewinder driver is built in, but in older operating systems, such as WindowsME, you will have to install the drivers and test the software. You can download these from Microsoft. I recommend getting the latest drivers.

The driver has a test program that allows you to test your controller. When you run the program, you can see the effects of the steering wheel, as well as the pedals. If you don't see these effects, connect the original pedals and test those. If they work and your Workboard does not, you need to go back and check your wiring. Pay particular attention to the MCP and RJ11 connections.

**Go Have Fun:** Warning!!! You will have so much fun that you may not want to stop a race. Just keep in mind that you can overdo it. This is where the turbo control comes in handy. You can set it where you are comfortable, and by adjusting the resistance of the bike as well, you can work your way up to a great workout.

My favorite games are NASCAR Heat and Need for Speed. In a single 10-lap race, I can burn over 500 calories. So far, the best I can do is fourth place. Need for Speed is cool because I can remove all the cars and just cycle through the various maps at my leisure.

## Going Farther

We are barely tapping the power of the DiosPro chip. There are several pins that you could add special functions. How about a switch that turns on an automatic brake? You could

also add a sensor that detects the amount of resistance set and adjust the turbo accordingly. Try networking two computers! Most PC games allow network play. This would allow you to race your friends and family.

I want to build a PlayStation and Xbox version of the controller. The concept is identical to the one shown here and it's just a matter of figuring out how the pedals are connected.

If you have figured out the pedal connections for other steering wheels, let me know and I will try and add them to the project. Be sure to visit the Control Your World Forum at [www.kronosrobotics.com/forums/](http://www.kronosrobotics.com/forums/).

Also, updates and source file downloads can be found on the Kronos Robotics website at [www.kronosrobotics.com/Projects/Joybike.shtml](http://www.kronosrobotics.com/Projects/Joybike.shtml). Now, hit the trail! **NV**



*The technology builder's source for kits, components, supplies, tools, books and education.*

**Robot Kits For All Skill Levels**



**Books and Educational Kits**

**BEAM Kits and Components**

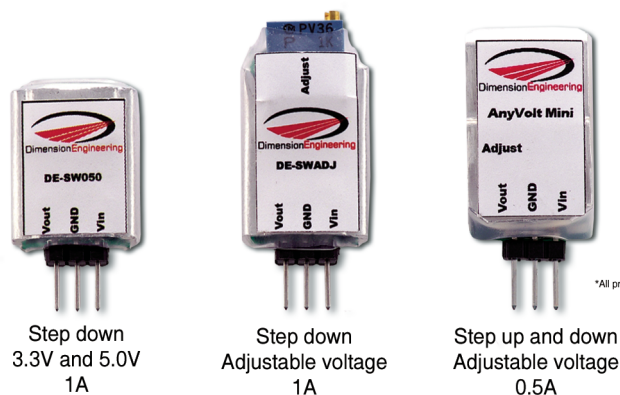
**ICs, Transistors, Project Kits**

**Motors, Frame Components and Scratch Builder Supplies.**

Order by Internet, phone, fax or mail.  
[www.HobbyEngineering.com](http://www.HobbyEngineering.com)  
**1-866-ROBOT-50**  
 1-866-762-6850  
 1-650-552-9925  
 1-650-259-9590 (fax)  
[sales@HobbyEngineering.com](mailto:sales@HobbyEngineering.com)  
 180 El Camino Real  
 Millbrae, CA 94030  
*Visit our store near SFO!*

**Most orders ship the day received! World-wide shipping. Convenient payment options.**

## The next generation of voltage regulators...



  
**Dimension Engineering**  
 899 Moe Dr #21, Akron, OH 44310

Dimension Engineering produces a series of voltage regulators unlike anything the world has seen before. Voltages can be adjusted on the fly with a screwdriver while switch-mode efficiency reduces heat. No external components necessary. To learn more please visit <http://www.dimensionengineering.com>





During certain times of the year, many of us think about reviving our gasoline-powered monsters who have been quietly sleeping in our garages and/or backyards. Maybe it's a bass boat, jet ski, riding lawnmower, RV, or motorbike. Whatever it is, there is only one thing worse than hopping aboard, turning the key, and discovering that the starting battery is completely dead.

**That is, putting the expensive automatic battery charger on it and then finding out that the battery will no longer accept a charge.**

**The battery is totally trashed.**

# CHARGE ALL BATTERY CHARGER SWITCHER

**E**ven the cheapest lead-acid battery will cost between \$20-\$30 to replace, not to mention the hassle of yanking it out, installing the new one, and then explaining all of the battery-acid holes in your clothing to the wife.

Sometimes this happens and you think back and realize the dead battery is not very old — maybe only one or two seasons. If you have many of these in your collection of gas-engine devices, this sort of thing can get expensive quickly — two or three batteries a year is more than \$100 down the drain. You know you can get longer life out of them by keeping them properly charged, so the two alternatives are to either buy an automatic charger for every single battery or, remember to change the charger over to another battery at regular intervals. The first choice is expensive; a good, truly “automatic” charg-

er will run \$50 or more. The second choice is too high-maintenance if you are a busy person. If you forget to move the charger to the next battery, you may end up with another dead battery, anyway. Some municipal utilities, who depend on many diesel engines, actually hire a full-time employee whose sole responsibility is to make sure all starting batteries in the system are charged, conditioned, and up to snuff. It is very likely we would not be able to hire somebody to perform this service for us.

Wouldn't it be great if you could take the one decent battery charger you do own, and have it automatically switch its output between all of the batteries in your collection at regular intervals?

## Lead Acid Battery Chemistry

A 12 volt lead-acid battery is basically a box containing six water-tight compartments or cells. Each cell has one plate assembly made of lead (Pb) and another of lead dioxide (PbO<sub>2</sub>), immersed in a strong sulfuric acid electrolyte (H<sub>2</sub>SO<sub>4</sub>). Lead combines with SO<sub>4</sub> to create PbSO<sub>4</sub> (lead sulfate) plus one electron. Lead dioxide, hydrogen ions and SO<sub>4</sub> ions, plus electrons from the lead plate, create PbSO<sub>4</sub> and water on the lead dioxide plate. As the battery is discharged, both plates build up PbSO<sub>4</sub>, and water builds up in the acid. Conversely, as the battery is



charged, lead and lead dioxide form again on the plates and the electrolyte reverts back to sulfuric acid.

Although the chemical process is normally reversible, when a battery is completely discharged, some of the lead sulfate becomes bonded to the lead in such a fashion that it is difficult or impossible to dislodge it through a normal charging procedure. If one carefully applies an equalization charge (a very vigorous charge at C/20), it may be possible to reverse this effect. But eventually, after enough repeated deep discharges, the battery will no longer accept a full charge at all. Since there are six cells, there are six chances that an accidental deep discharge will damage one of the cells to the point where the battery will no longer come up to full charge voltage.

This problem is even more inherent in starting batteries (versus deep-cycle types) because starting batteries are optimized to provide huge output currents for a short duration and have more fragile plate geometries to accomplish this. One estimate says that less than 30% of all lead-acid batteries sold actually make it to a 48 month life. The death rate of batteries that are not charged up in regularly-used vehicles (like the bass boat) is much, much higher.

## All Chargers Are Not Equal

There are many ways to build battery chargers, and the general rule-of-thumb is you get what you pay for. There are three classes of lead-acid battery charger: one is a bulk or heavy duty charger; a trickle charger; and a "float" charger. If your battery is in good shape, a well-designed trickle or float charger is sufficient to keep it healthy. The problem is that because they supply only small amounts of charge, they are often very inexpensively constructed and poorly designed. A trickle charger that does not shut off properly when the battery reaches full charge will eventually boil out the elec-

trolyte just as surely as a bulk charger will. Boiling out the electrolyte is another great way to ruin a lead-acid battery.

As an experiment and, partially out of desperation from losing another two batteries over the winter, I went down to the local freight tool store and purchased four new identical float chargers for under \$10 each. When I got them home, I measured the output of each with a voltmeter and, between the four, the output float voltages varied from 12.83 to a whopping 19.87 volts. The packages stated the chargers were supposed to be set to 13.5 volts — reasonable for a float charger — but these were not even close.

Even worse, they were not stable — after placing them on new gell cells for a few hours, their outputs drifted to an even larger spread of 12.24 to 21.2 volts. Forty dollars worth of chargers were essentially worthless and required a tedious argument with the store manager to return them — after all, how could four "new" float chargers be defective?

The best route is to invest in a single, high-quality fully-automatic bulk rate charger. This will allow you to bring the battery up to charge quickly after it has been discharged at a high rate, and then provide a properly calibrated tapered charge and shut-off when the battery reaches full charge. But what if you have only one decent charger and many batteries to charge?

## Why Not Charge All Batteries in Parallel?

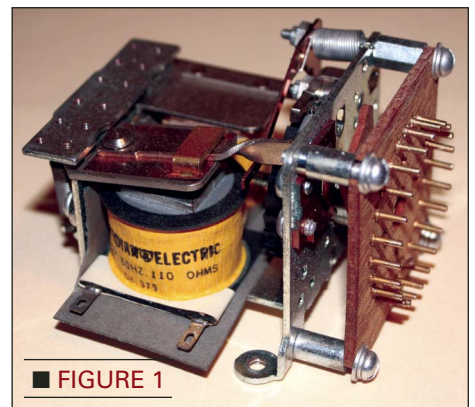
All of the batteries in your collection will not be exactly the same — they will have different capacities; some will be older than others; some will charge at different rates. If you put a number of batteries in parallel the "weak sister" will pull all of the others down to its level. Eventually, you could even ruin all of your batteries trying to charge them together in parallel. It is always best to charge a lead-acid battery individually, and let the charger's "intelligence" bring it up to an optimal level for that particular battery.

## One Solution

The solution I decided on was to build a charge distribution switcher that would allow me to use a single, high-quality automatic charger to charge all of my batteries, in turn. The switcher had to be simple, reliable, and cheap. To accomplish this, I went back to 20th century technology and employed an old-fashioned stepper relay at the heart of the project.

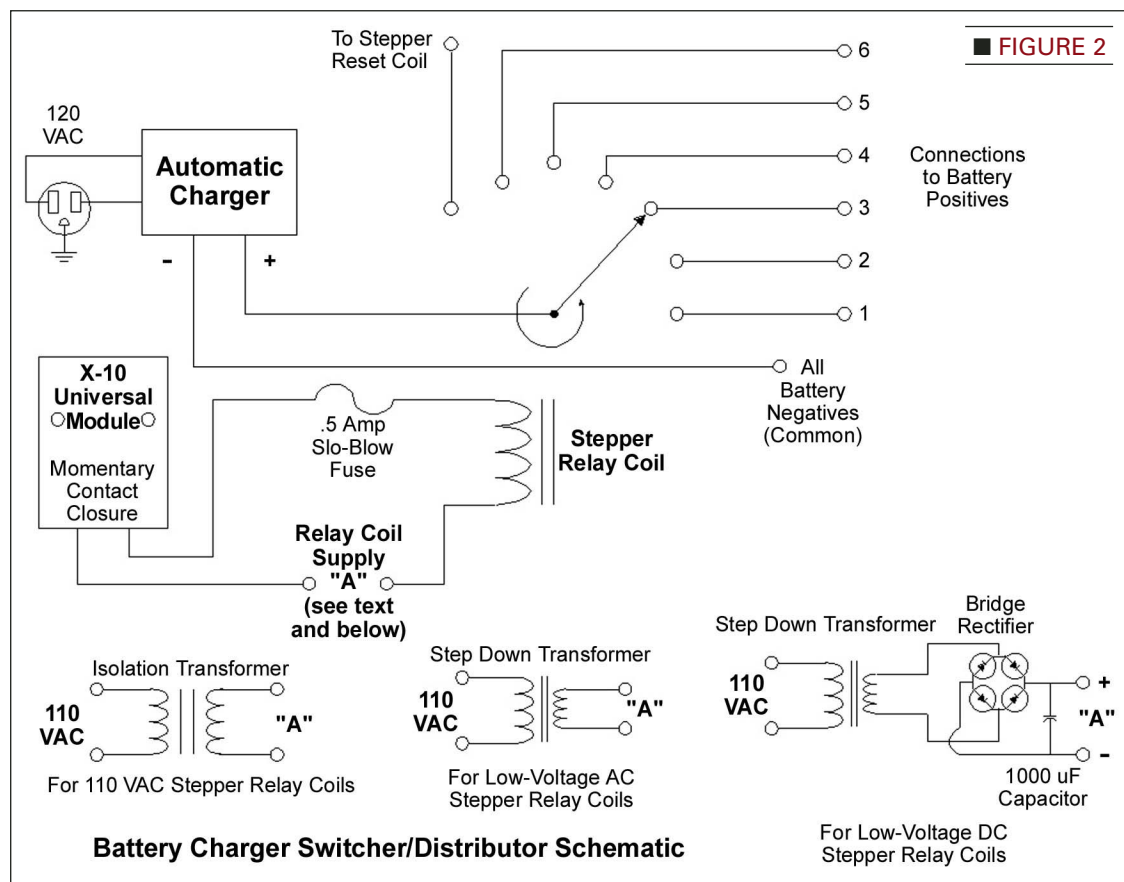
Stepper relays are a peculiar piece of technology originally employed in a variety of applications from elevators, telephone switches, jukeboxes, and pinball machines. Solid-state technology has since made them obsolete, but they are still amazingly effective for switching moderate currents and voltages with high reliability. A basic stepping switch has a single input terminal (the stepping terminal) and multiple output terminals. Connection from the input terminal to the outputs is controlled by an internal rotary contact, or wiper, which rotates like the hand on an analog clock, so as to connect the input terminal to whichever output terminal it is currently pointing at (Figure 1).

The position of the wiper is advanced with an integral electromagnet. Each time an electric pulse is applied to the electromagnet, the rotary contact is advanced one position, and connects the input terminal to the next output. Some stepping switches rotate continuously around to the "home" position after they reach the last position, while others have a separate



■ FIGURE 1





ty to use your home controller to set the charge intervals at will.

## Putting it Together

Begin by determining your stepper relay actuator voltage and building a power supply. For an AC-powered actuator, use a step-down or isolation transformer; for a DC-powered actuator, build a simple brute-force DC converter supply (Figure 2), or use a DC wall wart supply of the appropriate voltage. It would be wise to mount your stepper relay in an exterior-grade weatherproof electrical box to keep moisture away from the relay, and to

“reset” coil and a return spring. If you don’t already have one of these in your junk box, they can be found at popular online auction and hardware surplus sites for only a few dollars apiece. I have also seen versions of these using “motorized switch” as a search phrase.

The only two critical specifications to note in selecting a stepper relay is the actuator voltage (usually a choice between 24V or 110V; AC or DC), and the current switching limitation of the unit. Since we are only trying to keep our bank of batteries properly condi-

tioned, we do not expect to be passing exceptionally high current through our stepper relay contacts. In any case, our circuit will provide protection against contact overloads.

In order to trigger our stepper relay, we are employing an interesting variant of the standard X-10 appliance module, called a “universal module.” This module accepts standard X-10 commands, but will provide a momentary three-second relay contact closure, perfect for advancing our stepper relay. The beauty of this setup is in its simplicity, and in the abili-

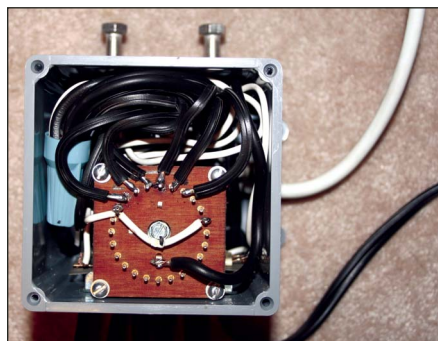
minimize the explosion hazard presented by arcing relay contacts.

I used two bolts mounted through the side of my box to serve as the power input posts. You can simply use the battery clamps on your battery charger to connect to your charge distribution unit. It would be a good idea to put a 10 amp fuse in series with one of the input legs to protect your relay contacts against a shorted output or excessive load. If you have a spare circuit breaker in your junkbox, you can use this instead of the fuse.

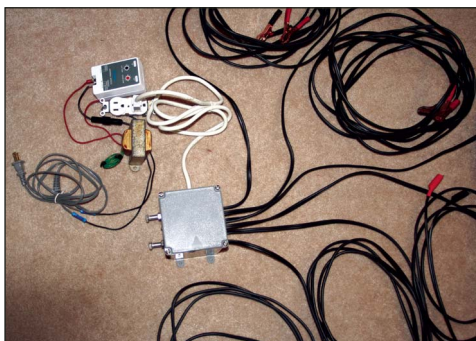
I ran individual charger clip leads from my box long enough to reach all of the batteries in our barn. One important point here is to try and keep these distances to a minimum. You will experience a significant voltage drop through any great length of wire, so in order to keep the cost of the project to a minimum, I used 12 gauge appliance zip cord and kept the lengths to under 20 feet for any leg.

The easiest way to deal with all of these leads is to drill holes for each in

**FIGURE 3a**



**FIGURE 3b**



## Battery Charger Switcher

the side of the box and, after passing them through, simply tie an overhand knot inside as a strain relief. Solder all of the ground ends together and solder each of the positive leads to one of the relay outputs. If your relay is a "make before break" type, you may wish to use every other contact to avoid tying your two consecutive batteries together in parallel while a switching event occurs. There is no inherent danger in allowing two batteries to temporarily be connected in parallel unless they are at greatly differing states of charge, or one of them is completely shorted through. You will need to remember to program two "On" signal pulses to advance the charge, however.

Tie in your relay power supply in series with the X-10 universal controller module contact closures and the relay actuator coil. If your relay is a 110 VAC type, observe AC wiring safety. Try to use an isolation transformer, if possible. If you are operating your stepper relay from a low-voltage DC or AC wall wart, you are working with a good margin of safety already. Fuse this circuit to protect the actuator coil from burnout should it somehow be stuck in an energized state. A slow-blow 0.5 amp fuse should be sufficient here.

Since my stepper relay came out of a telephone switching system and needed to be reset, I wired the next available output contact to provide a reset pulse when it had cycled through all of the batteries I wanted to charge. If your reset relay coil needs 110 VAC, you can either add a separate 12 VDC relay as a switch to energize the reset coil with your stepper coil power supply, or use a separate X-10 appliance module and command to trigger the reset function. Some stepper relays can also be mechanically reconfigured to disable the need to reset them entirely.

When you are done, your project should look something like Figures 3a and 3b.

Finally, program your X-10 home controller to send out an "On" to your universal module's address to test your charge distribution unit. Each "On" command should sequence the charger output to the next contact and corresponding charging clip lead.

### Results

I set my controller to send out a new "On" command once each day. After six batteries are charged, the next day the relay resets itself and the cycle begins over again. Each week, a different battery goes through a one-day charge cycle on the automatic battery charger; more than enough to keep it in top shape. I'm quite pleased that we can take the RV, riding lawnmower, go-cart, dad's old muscle car, and the bass boat out at any time knowing the battery is properly charged and ready to go — even after a long sleep.

### One Last Word

I know that some of you may look at this project and say, "I can't find a sequential stepping relay," but do not despair. I realize that some of us do not have the time to enjoy the hunt for unusual anachronistic components. So, if you happen to have a box of similar individual relays, you can actually accomplish the same thing with the application of a bit of logic.

Remember to be safe, and have fun whatever you do! **NV**

### PARTS LIST

| QTY    | DESCRIPTION  |
|--------|--|
| □ 1    | Automatic bulk rate charger  |
| □ 1    | Stepper relay (see text)   |
| □ 1    | X-10 Universal module  |
| □ 1    | PVC outdoor electrical junction box                                    |
| □ 2    | 3/8" x 2" bolts and nuts   |
| □ 1    | 1/2 amp slow-blow fuse   |
| □ 100' | 12-gauge appliance cord  |
| □ 12   | Battery clips or heavy-duty alligator clips                            |
| □ 1    | 110 VAC isolation transformer or DC relay coil power supply (see text) |

#### SOURCES OF STEPPER RELAYS

- [www.ebay.com](http://www.ebay.com)
- [www.surplussales.com](http://www.surplussales.com)

# PHILIPS

## Now Available from MCM Electronics...

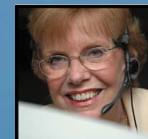
### Philips Accessories



Philips's line of innovative accessories includes:

- Remotes
- MP3 and iPod® accessories
- Headphones
- A/V switchers
- Care and cleaning products
- Webcams
- And much more!

For more info visit [www.mcmionone.com](http://www.mcmionone.com)



- Over 40,000 Products Stocked
- Access to over 1.5 million electronic parts and related products
- Installer/Dealer pricing program
- Quotation team, send us your quotes for quick response

call toll free  
**1-800-543-4330**

refer to or visit

[www.mcmionone.com/magazine](http://www.mcmionone.com/magazine)



**MCM Electronics**  
an in one company

Source Code: NVM45



# ATOMIC TIME

1010 Jorie Blvd. #332  
Oak Brook, IL 60523  
1-800-985-8463  
www.atomictime.com



ADWA101 - \$49.95

## 14" LaCrosse Black Wall WT-3143A \$26.95

This wall clock is great for an office, school, or home. It has a professional look, along with professional reliability. Features easy time zone buttons, just set the zone and go! Runs on 1 AA battery and has a safe plastic lens.

## Digital Chronograph Watch ADWA101 \$49.95

Our feature packed Chrono-Alarm watch is now available for under \$50! It has date and time alarms, stopwatch backlight, UTC time, and much more!



WT-3143A - \$26.95



WS-8248 - \$64.95

## LaCrosse Digital Alarm WS-8248U-A \$64.95

This deluxe wall/desk clock features 4" tall easy to read digits. It also shows temperature, humidity, moon phase, month, day, and date. Also included is a remote thermometer for reading the outside temperature on the main unit. approx. 12" x 12" x 1.5"

1-800-985-8463  
www.atomictime.com  
Quantity discounts available!



WS-9412U - \$19.95

## LaCrosse WS-9412U Clock \$19.95

This digital wall / desk clock is great for travel or to fit in a small space. Shows indoor temp, day, and date along with 12/24 hr time, apx 6"x 6"x 1"

Tell time by the U.S. Atomic Clock - The official U.S. time that governs ship movements, radio stations, space flights, and warplanes. With small radio receivers hidden inside our timepieces, they automatically synchronize to the U.S. Atomic Clock (which measures each second of time as 9,192,631,770 vibrations of a cesium 133 atom in a vacuum) and give time which is accurate to approx. 1 second every million years. Our timepieces even account automatically for daylight saving time, leap years, and leap seconds. \$7.95 Shipping & Handling via UPS. (Rush available at additional cost) Call M-F 9-5 CST for our free catalog.

## Nuts & Volts 2005 CD-Rom Now Available!



Now Only  
**\$24.95**

Buy 2 or more CDs  
for only \$19.95 each.  
Price does not include S/H.

It's here! The complete 2005 year of **Nuts & Volts** on CD. Stored as PDFs, you can print search, and easily store your digital magazine.

To order, go to:

[www.nutsvolts.com](http://www.nutsvolts.com)

or call

**1.800.783.4624**

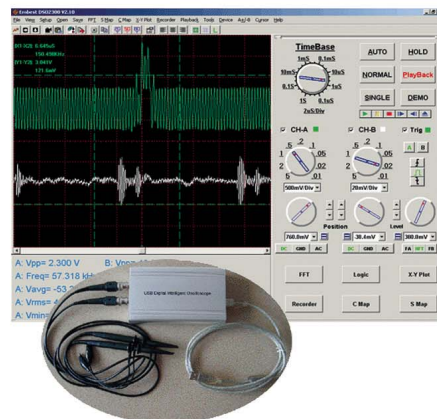
# 100 MHz DSO - Dual Channel

## PC-BASED - USB POWERED

100Ms/s, 2-channel USB1.1/2.0 Compatible Digital Oscilloscope

- Logic Analyzer, Spectrum Analyzer (FFT), Record & Playback, Voltmeter,...

- **Easy-to-use** with Intuitive User Interface



**SALE!**  
**\$320**

Sale ends  
Jan. 31, 2007

## World Educational Services

3093 C Beverly Lane,  
Cambridge, MD 21613

Phone: 410-228-7666

Fax: 410-228-7553

Email: [masc1@usa.net](mailto:masc1@usa.net)

Visit our website for wonderful  
products of our PICAXE line:

[www.world-educational-services.com](http://www.world-educational-services.com)

2,500 NEW  
**NATIONAL SEMI**  
PARTS

5,000 NEW  
**AMP**  
PARTS

2,500 NEW  
**MAXIM**  
PARTS

**Wow! Jameco just added 65,000  
new major-brand products!**

7,200 NEW  
**FREESCALE**  
PARTS

2,900 NEW  
**VISHAY**  
PARTS

19,000 NEW  
**TEXAS  
INSTRUMENTS**  
PARTS

2,800 NEW  
**MICROCHIP**  
PARTS

**The industry's fastest  
growing product offering!**

You know that Jameco's catalog  
always offers over 99% *in-stock  
availability*—the best of any elec-  
tronic components distributor...

And now, they have the  
fastest growing product offering  
in the industry!

They've just added another  
65,000 *new parts* to their online  
catalog; and it's everything  
from ICs to passives, optos to  
interconnects, power supplies  
to electromechanical.

**Service & Availability!**

As Design Engineers  
know, Jameco offers great  
service, selection and  
same-day shipping!

Now you can get those  
same benefits for even  
more great brands...

6,200 NEW  
**FAIRCHILD**  
PARTS

3,000 NEW  
**AVX**  
PARTS

**Check out these new  
and expanded lines:**

**Aavid Thermalloy •**  
**Alcoswitch • AMP •**  
**Amphenol Connex •**  
**Atmel • Augat • AVX •**  
**Bourns • Buchanan • Comair Rotron •**  
**Condor Power Supplies • CTS •**  
**Cypress • Dallas Semiconductor •**  
**Fairchild • Freescale Semiconductor •**  
**Grayhill • Intel • Intersil • ITT •**  
**C&K Switches • Lattice**  
**Semiconductor • Lite-On •**  
**Maxim • Microchip • Micron**  
**Technology • Molex • National**  
**Semiconductor • Panasonic •**  
**Philips • Power-One •**  
**Raychem • Renesas**  
**Technology • Sandisk • ST**  
**Micro • Texas Instruments •**  
**Toshiba • Tyco Electronics •**  
**Vishay Intertechnology...**

**Get it here. Right now:**

**[Jameco.com/NVQ](http://Jameco.com/NVQ)**

**JAMECO**  
ELECTRONICS

**Great Products.  
Awesome Prices.**







I initially became involved in macro — or close-up photography — as part of my job, which involves failure mode analysis of electronic circuitry. Be sure and read the sidebar for a discussion of why photographs of small objects are called *macro* photography.

**With components becoming smaller and smaller, taking a decent photograph has proven to be increasingly difficult.**

■ FIGURE 1. A fine application for macro photography — documenting your coin collection.



# BUILD A RING FLASH FOR MACRO PHOTOGRAPHY

I really became interested in macro photography after realizing how extensive my son's coin collection had grown. Loving photography, I immediately thought about documenting his collection. I had faced challenges at work, but capturing the exquisite detail found in many coins, such as the example shown in Figure 1 — a post-World War 2 British penny — was a bit trickier.

The main problem stems in that for macro photography, one has to come very close to the object being photographed, usually no more than a couple of inches from the lens. Although newer cameras and lenses can handle this extremely short focusing distance, the challenge lies in how to illuminate the object, as the camera and photographer project shadows into the object. Low light conditions lead to uneven contrast and require both slow shutter and wide apertures, which result in blurry images and a shallow depth-of-field. The solution to this issue has been to employ lens-mounted ring flashes and illuminators,

but these can be expensive.

Fortunately, with component miniaturization and with the newer, high brightness white LEDs, it is possible for the hobbyist to build one. Figure 2 shows the assembled project on my old trusty Sony CyberShot. If your camera has a threaded front lens and a non-dedicated flash hot shoe, you may benefit from this project.

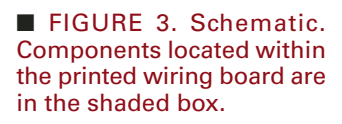
## Circuit Description

White LEDs are a major improvement over incandescent lamps for portable illumination, and in particular for photographic use. They are rugged, their color temperature does not change dramatically with weakening batteries, and they are far more efficient in the electrons to photons conversion. Unfortunately, they cannot be connected directly to a voltage source; its current must be regulated. This is traditionally accomplished with a ballasting resistor, which is very wasteful.

For the large number of LEDs — 15 in total — required for this project, a switchmode power supply is required. Since white LEDs each have about 3.5 volts forward drop, and there are five of each in the three series, a boost topology is mandatory.

Since white LEDs are becoming

■ FIGURE 2. The completed project mounted in a camera. On the camera's top is the power pack; on its lens, the LED ring.







popular, semiconductor vendors have designed many integrated circuit solutions. The question is which one to use? All of them come almost exclusively in SMT packages. Some of those packages — like SOT and SOIC — are manageable to the hobbyist. Others — like TSSOP and QFP — would be next to impossible to assemble correctly without the proper skill and high-dollar specialized tools. Therefore this, and other features like simplicity of use, narrowed the choice to National Semi's LM2731Y, which is the heart of the circuit. This is a fully integrated boost converter with its own internal power FET and oscillator. Two versions are available, depending on the internal oscillator frequency. In this project, the 600 kHz, Y-version is chosen, as it is more layout-forgiving than the 1.6 MHz X-version.

As shown in the schematic of Figure 3, this powerful IC is U1, and only a handful of additional components are required to complete

the boost circuit. These are D1, L1, and C1a and C1b. C2 is an input decoupling capacitor, indispensable for proper operation.

Current feedback is taken from the voltage sample across R1, and fed to U1's feedback input. When the current across the series string LED1 through LED5 equals approximately 20 milliamps, the developed voltage will equal that of the internal reference and the current is in regulation. The voltage drop across this resistor is only about 7% of the total voltage, resulting in a small efficiency penalty. The other two LED strings — LED6 through LED10 and LED11 through LED15 (both having equal limiting resistors R2 and R3) — will current-mirror the first LED string to an acceptable degree.

Of course, since the main portion of the circuit and its battery are attached to the camera via the flash mount — whereas the LED strings are in a ring which is screwed to the lens — there must be a way to detach them

and reconnect later. This is accomplished with a six pin DIN plug and receptacle pair J1 and P1. Although this adds flexibility to the project, an accidental disconnect while the circuit is operational can permanently damage the circuit; in the absence of current feedback, the output voltage will increase until the device self-destructs. To prevent this, two features are built in: the first is zener diode D2, which will start conducting current when an overvoltage condition occurs and continue providing feedback to the circuit. The second, and most important, is that two pins of the connector are used to break the current flow from the battery, effectively powering down the circuit.

Although the circuit could work like this, further enhancements are required to improve the battery's operating life. The total current consumption is about 140 milliamps, quite a chore for a continuous draw on a nine-volt battery. Therefore, further circuit refinements are necessary. First, during normal operation luminous power — and thus current draw — is roughly halved. Second, the illuminator is triggered — via the camera's hot shoe — to full power during a short period, to fully illuminate the object.

The first function is comprised of an astable oscillator U2 and its associated components R4, R5, C7, and C8. It produces a 210 Hz square wave, at close to 50% duty cycle. The second function is comprised of a monostable U3 and its associated components R6, R7, C5, and C6. It produces a positive pulse about 1/3 of a second long. The circuits employ the ubiquitous 555 CMOS timer. Both their outputs are Or'ed together with dual diode D4. The signal is applied to U1's shutdown input. The circuit is enabled with a logic high at the input. Therefore, in normal operation, the circuit sees

## WHY THE NAME MACRO PHOTOGRAPHY?

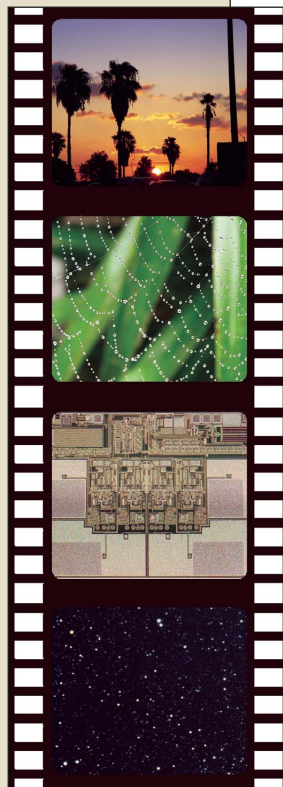
A very valid question, especially since it involves taking images from small objects, so how is the term "macro photography" defined?

In traditional photography — which comprises the vast majority of images shot — the subject being photographed is many times larger than the photo sensor's area. By photo sensor I mean either film or an electronic device. Clearly, the sunset at the top of Figure 4 matches that definition, as would a person's portrait or your pet's photo.

As the size of the object shrinks, and the object being photographed starts to equal in size to that of the sensor, we enter the realm of macro photography. Of course, since the photographic sensors are small, the object must be small. There is no cut and dried definition for macro photography, but I like the definition found in the now defunct Konica-Minolta website, which defined a macro as an image of an object ranging from ten times to one tenth the size of the sensor. The delicate water droplets hanging from a spider web in the next image of Figure 4 match the description, as would the image of an insect.

Smaller images than one tenth the sensor's size are now part of micro photography, and a microscope is absolutely required. We have seen those ... an amoeba, a fly's multifaceted eyes ... however, we are in an electronics magazine, and the photo of an IC's silicon guts in the next image is a nice example of micro photography.

Last but not least is astro photography. Here the objects are trillions and trillions of times larger than the sensor. Astronomical objects ranging from the moon to galaxies. The starry sky image taken through a telescope at the bottom of Figure 4 is such an example.



■ **FIGURE 4.** Here are some examples of Normal, Macro, Micro, and Astro photography.

roughly a 50% duty cycle square wave, and total power is thus halved. When a picture is taken, the camera's hot shoe pulls low U3's trigger input, and the resulting positive output pulse will maintain full power for the duration, reverting to half power afterwards.

Most of the circuit is built on a small board, shown as a shaded box in the schematic. There are some external components, like the LED array itself, but also a momentary "test" pushbutton to override the half power option and set the circuit to full power. This is useful for adjusting the exposure. Additionally, an external power jack J2 is employed to feed — via a wall-wart transformer — 6 to 10 volts DC when prolonged use is required. U4 is a low power five-volt regulator which feeds the timers, and this completes the circuit.

## Building the LED Ring

This project consists of two parts: the power pack and the ring itself. Let's discuss building the ring first, since your camera **MUST** have an essential attribute for this project: a threaded front lens. The threaded lens will allow you to mount a step-up ring adapter, which is available from many photographic shops. These adapters allow you to thread larger diameter filters and accessories to the camera's lens. What you need to do is procure an adapter with an inner diameter equal to that of your lens (in my case, it was a 58 mm), and for the outer diameter, a larger one which will allow the LEDs to be mounted on the rim (which again, in my case, was 77 mm).

Employing a protractor, start by marking the inside ring surface each 24 degrees (360 degrees divided by 15 LEDs in the project). Then, at each mark, glue small perfboard squares that you have cut from a general-purpose perfboard. Solder the white LEDs, observing their polarity, on each square. Then wire the LEDs to form three strings of five LEDs each. Connect the first anode of all the series together, and then wire the last anode of each series individually.

■ **FIGURE 5. Detail of the LED ring.**

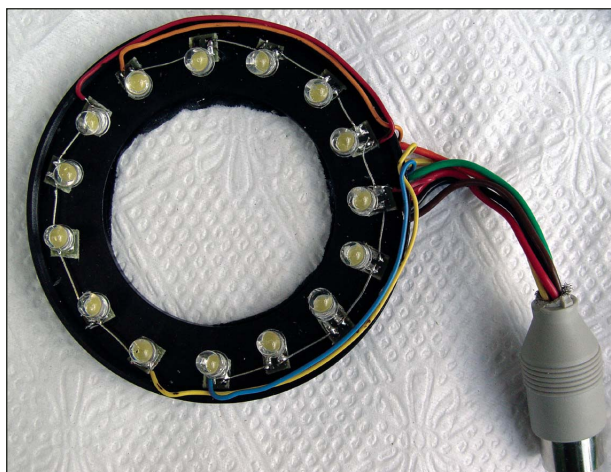
These four wires will be soldered to another small section of the perf-board which has been glued to the ring's back, and to which the wires from the DIN plug are attached. The DIN plug has six wires, but the other two serve the purpose of forming a power interlock which will disconnect battery power from the circuit, in case the LED array is disconnected from the power pack as shown in the schematic and explained in the previous section.

Figure 5 — showing an example of an assembled LED ring — should clarify the description above. I strongly recommend using different color wires for all the wires, to avoid miswiring.

The white LEDs are the heart of the project, and they are a substantial part of the cost. Therefore, I understand that there will be a great temptation to purchase them from the cheapest stock one can find. This is perfectly fine, but please watch out for two caveats: the first is that the LEDs must be specified for a continuous current of 20 mA. The second is surplus LEDs can vary in brightness and color. Therefore, buy a few extra than the amount actually required in case one of them is dim.

Please remember that white LEDs are much more ESD sensitive than the more common

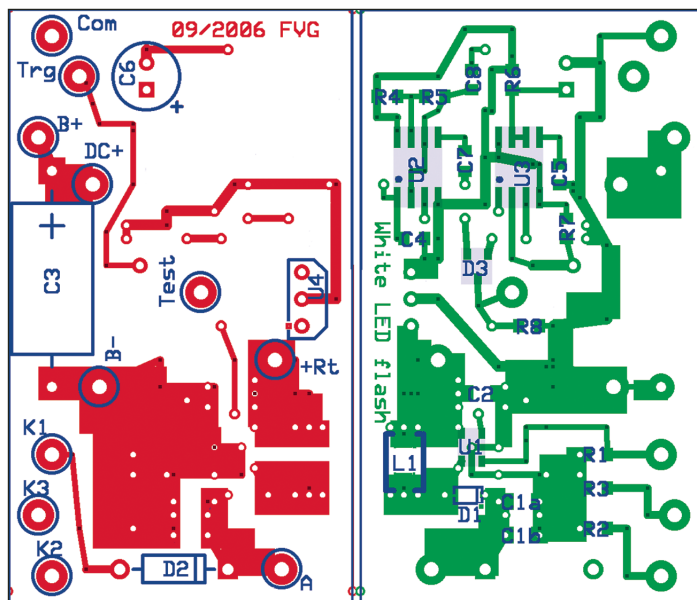
■ **FIGURE 6. Suggested PWB. Thru hole components mounted on the bottom (red) side; SMT components mounted on the top (green) side.**



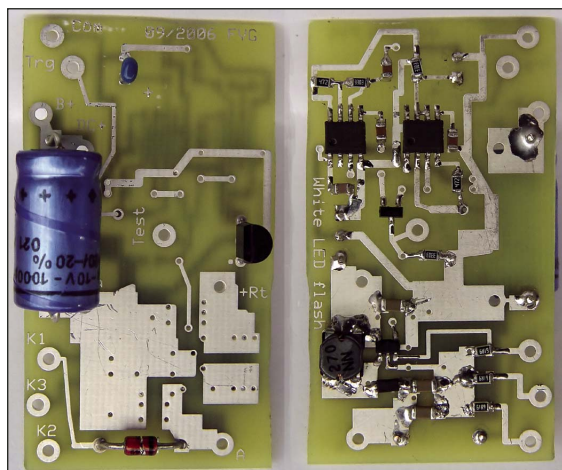
red or green relatives; observe proper handling and soldering procedures.

## Building the Power Pack

Before I start, let's clarify a photographic term. The "PC" cord and adapter term mentioned below is not related to a "printed circuit" board. Rather it is a special coaxial connector that has been used for a long time in photography to synchronize flashes to cameras. To avoid confusion, the board where the components are mounted will be called a "printed wiring" or PW board. For compact and high performance circuits like the power pack, surface mount technology devices are required in certain sections. To mount







■ **FIGURE 7. Photos of the complete PWB prior to wiring.**

employed; the lower side in the drawing in Figure 6 to mount the thru hole devices, the upper side to mount the SMT devices. Figure 7 shows a photo of the same board layout with components mounted. The board's length is such that it fits nicely inside the specified plastic housing which also has a compartment for a nine-volt battery.

Solder all of the SMT

a SMT device, a PW board is a must. In this project, both sides of the board are

components first, as the PW board must be level. A fine pointed, low

wattage iron is a must, as it is fine gauge solder. Tweezers are required to hold the components being soldered, and unless you have eagle vision, a magnifying glass is very useful to inspect your work. I also recommend getting at least an extra device for all the smaller SMT components, since they are easily dropped and lost. Take care with the ceramic chip caps, they are fragile and easily cracked if the board is flexed after being soldered. The crack will not be immediately evident and could cause a failure later.

Please note the orientation of the SOIC8 circuits, a dot indicates pin 1.

Likewise, D1's cathode end is indicated by a dot. For D3 and U1 — which have a 2:1 pin and 3:2 pin configurations, respectively — they will only fit properly one way. For the thru hole components, D2's cathode is marked, and U4's input is marked with a dot.

Don't worry if the via holes (the holes that connect one side of the board to the other) which are closest to the SMT devices get filled with solder while you are soldering the devices. This actually improves both electrical and thermal conductivity.

After the board is completed, attach all the wires to it. There are 11 wires going to the board from the connectors, switch, and battery holder. Once again, thin, color coded wires are a must.

Please note that C6 — a 1  $\mu$ F capacitor — may be either ceramic or electrolytic. The former is preferred, as it usually has a tighter tolerance and there are no polarity requirements. The schematic shows the appropriate polarity, in case an electrolytic one is fitted.

You'll have to drill the enclosure's front panel to mount the DIN connector and pushbutton switch, and one side for the power jack. Then drill the bottom of the enclosure for the mounting holes for the hot shoe adapter. Once secured with screws, a little epoxy glue will firmly bond both together.

## PARTS LIST

### PART

- ☐ U1
- ☐ U2, U3
- ☐ U4
- ☐ D1
- ☐ D2
- ☐ D3
- ☐ LED1 through LED15

- ☐ R1 through R3
- ☐ R4, R7
- ☐ R5, R6, R8

- ☐ C1A, C1B, C2
- ☐ C3
- ☐ C4
- ☐ C5, C7, C8
- ☐ C6
- ☐ L1

- ☐ P1
- ☐ J1
- ☐ J2
- ☐ SW1
- ☐ B1

- ☐ Hot Shoe to PC Adapter
- ☐ Sync Extension Cord PC Male
- ☐ Step-up Ring
- ☐ Plastic Enclosure
- ☐ Printed Wiring Board

### DESCRIPTION

LM2731Y Boost Converter [SOT23-5]  
LMC555 Timer [SOIC8]  
LM78L05 Regulator  
MBR0520 Power Schottky Diode [SOD123]  
1N4747A Zener Diode  
BAT54C Dual Schottky Diode [SOT23-3]  
T1 3/4 White LED (*see text*)

61.9 ohm, 1%, [0805]  
4.7K, 5%, [0805]  
330K, 5%, [0805]

2.2  $\mu$ F, 25V, Y5V Ceramic, [1206]  
1,000  $\mu$ F, 10V Axial Electrolytic  
0.1  $\mu$ F, 50V Ceramic, [0805]  
0.01  $\mu$ F, 50V Ceramic, [0805]  
1  $\mu$ F, 16V Ceramic Preferred, Electrolytic okay to sub.  
27  $\mu$ H, 0.97amp [CR54-270MC]

6 pin DIN Plug  
6 pin DIN Jack  
Power Connector  
N.O. Momentary Pushbutton  
9V Battery and Connector

B&H Photo GBHSPCA  
B&H Photo GBPCPCS1  
*See text*  
Pactec HM-9VB

### NOTES

- 1) The information in square brackets [] indicates the exact SMT package size required to fit the suggested PW board.
- 2) No information indicates a thru-hole device.
- 3) It is okay to employ tighter tolerance components.
- 4) All ceramic caps  $\pm 10\%$  tolerance.

## Build a Ring Flash for Macro Photography

The hot shoe adaptor serves as a mounting platform for the enclosure, but also provides the timing for the flash strobing. Connect the sync PC cord's male side to the hot shoe adaptor. After measuring the proper length, cut away the connector at the other end, and strip the wire that you'll attach to the PW board. Drill one final hole on the enclosure's bottom to cross the cord. The connector is polarized; with a multimeter, determine which wire connects to the camera's ring, which is the camera's ground. This wire goes to the "common" terminal in the board.

### Using the Project

This is a photographic project after all, so here are some associated tips.

The first is related to the white balance of the LEDs. White balance, or color temperature, is a measurement of the light spectra of a white source. White LEDs have a very high color temperature, which means that their spectra is highly skewed towards the blue component. If uncorrected, your images will be bluish. There are two ways around this: the best is to adjust your camera for this color temperature, if the camera is equipped for manual white balance adjustments. If it lacks this feature, the other option is to pre-set the camera white balance for "cloudy" conditions, and then use your favorite photo editor software to fine-tune it from there. In any case, a white or neutral gray background is required to ensure the proper color is rendered.

The other tip is about adjusting exposure. In normal operation, the unit is operating at half power, and thus when it flashes at full power, the actual exposure will not be correct. Push the test button to set the exposure, and then lock that exposure. Another way — if no exposure lock is available and you have to set the

exposure while keeping the flash in half power — would be to adjust the exposure value at -1.0EV from the actual reading. Then as the flash fires at full power, the image will be exposed properly.

Even at half power the project does consume substantial current for a nine-volt battery. Stay away from general-purpose batteries or the cheaper rechargeables. **NV**

### SOURCES

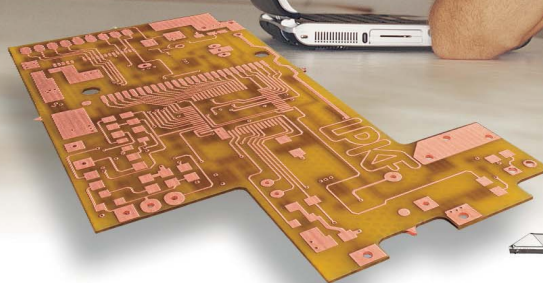
■ All electronic components available from: [www.digikey.com](http://www.digikey.com)

■ Hot shoe adaptor and PC sync cord available from: [www.bhphotovideo.com](http://www.bhphotovideo.com)

■ Step up rings available from: [www.2filter.com](http://www.2filter.com)

■ Plastic enclosure available from: [www.pactecenclosures.com](http://www.pactecenclosures.com)

"Producing prototypes  
on-the-fly  
allows me to be more  
Creative"



### ProtoMat® S-Series PCB Milling Machines

Electrical engineers agree: with a Protomat S-Series prototyping machine at your side, you'll arrive at the best solutions, fast. These highly accurate benchtop PCB milling machines eliminate bread-boarding and allow you to create real, repeatable test circuits—including plated vias—in minutes, not days.

- Declare your independence from board houses
- Affordable, entry-level price tag
- The best milling speed, resolution, and accuracy in the industry
- Single-sided, double-sided, and multilayered machining without hazardous chemicals
- Optional vacuum table and autosearch camera for layer alignment



**LPKF®**

Laser & Electronics

For complete details visit:  
[www.lpkfusa.com](http://www.lpkfusa.com)

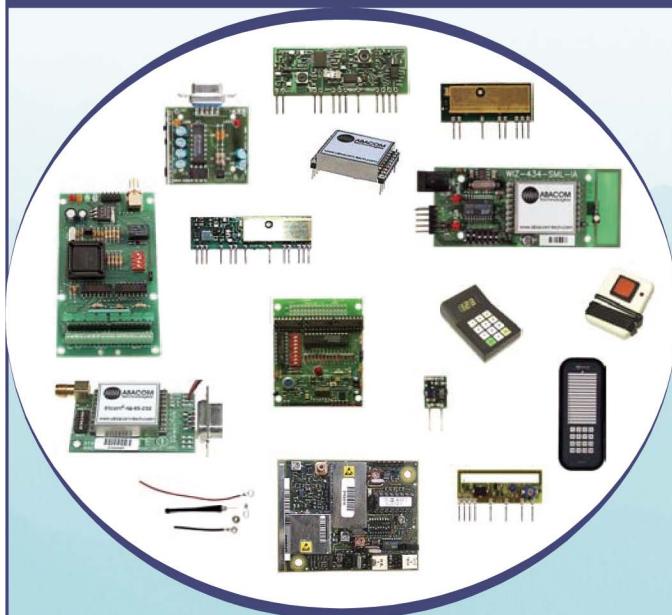
or call:  
**1-800-345-LPKF**

### AUTHOR BIO

■ If there is enough interest, I may offer PWBs for the project; contact me at [fernando.v.garcia@netzero.com](mailto:fernando.v.garcia@netzero.com)



# RF MODULES



WWW.ABACOM-TECH.COM



Tel: +1(416)236 3858  
Fax: +1(416)236 8866  
abacom@abacom-tech.com

Resistors  
Diodes  
Order PCB  
Get **FREE** parts  
Capacitors  
Transistors  
Connectors

Only \$50 for 5pcs 4"x4" 2L  
Free Solder mask and silkscreen!



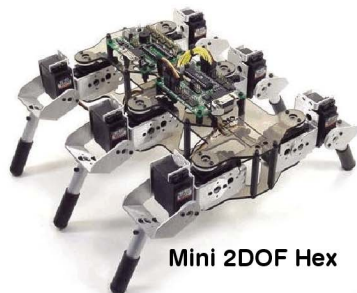
**FREE**  
With first order



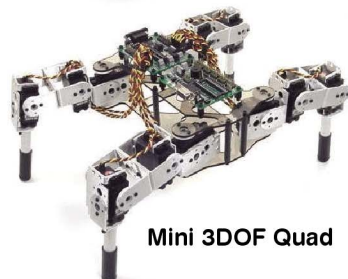
Http: // **EzPCB**. COM  
Sales@**EzPCB**. COM



Biped BRATs



Mini 2DOF Hex



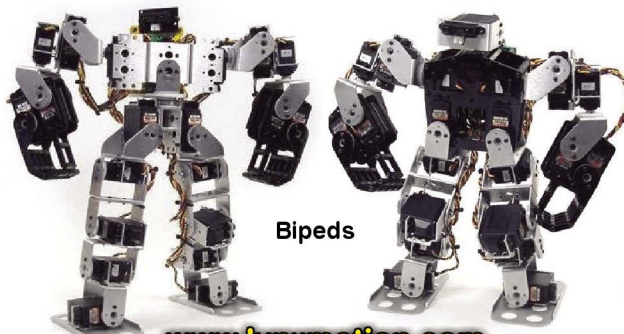
Mini 3DOF Quad



## The Lynxmotion Servo Erector Set Imagine it... Build it... Control it!

With our popular Servo Erector Set you can easily build and control the robot of your dreams. Our interchangeable aluminum brackets make the ultimate precision mechanical assemblies. Our Visual Sequencer for SSC-32 provides powerful PC, Atom, or BS2 based control.

Visit our huge website to see our complete line of aluminum and Lexan based robot kits, electronics, and mechanical components.



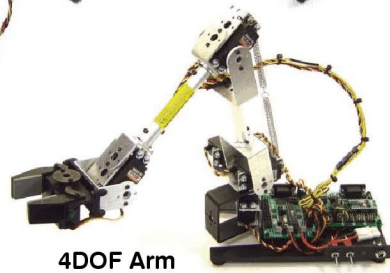
Bipeds



Johnny 5



Round 3DOF Hex



4DOF Arm

[www.lynxmotion.com](http://www.lynxmotion.com)  
Toll Free: 866-512-1024

Images represent a fraction of what can be made!

SES now has 52 Unique Aluminum Components!

**www.goldmine-elec.com**

Visit Us Online!

**Updated Website Features:**  
Improved Navigation  
Create Personalized Accounts  
Easy "Quick Ordering"

**New Shopping Cart Features**  
Create your own Wish List  
Sale Items & New Arrivals  
Online Catalog

**ELECTRONIC  
GOLDMINE**

### SCI-FI Sound Effects "THERIMIN" Kit

This kit utilizes two light sensors: one controls the frequency and the other modulates the sound. Simple one IC circuit with built in speaker and an RCA jack so you can send the sound to your amplifier if desired. Simply use your hands to produce some of the strangest, spookiest sounds you'll ever want to hear! Operates on one 9V battery (not included). Size of PC board 3 1/2" x 1 1/4". Complete with all parts, PC board and instructions. Skill Level 1.

**C6841 \$8.95 ea.**

### Blue Neon Lamp Bulb

Tiny neon bulb glows a bright blue instead of the usual orange glow. Operates from 120VAC and has a built in dropping resistor to allow for direct connection to the AC line. Brand new and rare. Size of bulb about .14" Dia. x .36" L (excluding resistor and leads). Package of 2.

**G15710 2/\$1.49**

### Space-Grade Silicon Solar Cell

This is an efficient highest quality space grade silicon solar cell with fine precision grid lines. This cell was made by Applied Solar Energy Co. for NASA. The cell produces 452mV open circuit voltage and 300mA short circuit current. The size is only 2cm x 4cm x .24mm Thick. This wafer thin cell weighs only .47 grams and has solder pads on top and bottom to solder wires to. Brand new!

**G16205 \$2.49 ea.**



**Toll Free Order Line:**  
**1-800-445-0697**  
Fax Line: (480) 661-8259

**We have over 4,000 electronic components and items online at discount prices!**

### Small Van de Graaff Kit with Demonstrations

This small battery operated Van de Graaff Generator produces up to 3/4" long sparks and is perfect for demonstrating many electrostatic phenomena. This unit is similar to larger machines but it won't produce the larger sparks and extremely high voltages. Has a 4 3/4" Dia. dome on top and produces about 25,000 Volts at a very low current (for safety). The voltage is harmless and it feels like a common "static shock" you might receive when you walk across a carpet on a dry day. Requires no soldering and can be assembled with just a screwdriver and pliers. The completed kit stands over 14" high and the base is 6" x 8". Very attractive, useful, and safe - requires 4 "C" batteries (not included). Complete with all parts, full color manual with instructions, experiments and several accessories for demonstrations. Skill Level 1.

**C6917 \$69.95 ea. Visit us online for our complete line of interesting kits!**

### Blinding Output Blue SMD LED

This LED emits a brilliant blue light with a viewing angle of 120 degrees when 3V to 4.2VDC is applied. It features a water clear lens and a .14" x .11" x .08"H white rectangular SMD case. Use a small tip low wattage soldering iron if you wish to solder leads to it. This is one of the lowest prices available anywhere for this high quality, high output blue SMD LED. Makes a great tiny book light for night reading when you use a 360hm resistor in series with a 9V battery. Brand new factory prime on tape and reel. Blue is 470nm.

**G13706 \$0.49 ea.**

### Standard Size CDS Cell

Small .29" x .24" x .07" CDS cell with long leads. The head of this CDS has been dipped in clean epoxy to help block moisture. Dark resistance over 4M. Light resistance under 1K.

**G15177 2/\$1.00**

### 8MM Super Power U.V. LED

Clear lens UV LED 8mm is our largest most powerful ultraviolet LED. These are brand new made by Handy Get part# 8N3CUV. These are great for lighting up invisible UV inks, blacklight posters, scorpions, some minerals, checking for counterfeit currency, etc. **NOTE:** As with all UV LEDs do not look directly into the device during operation. Brand new- Full length leads.

**G15221 \$1.99 ea.**

### Giant 10mm Rainbow Flashing LED

Giant 10mm crystal clear lens LED flashes a brilliant array of colors: Red, Blue and Green. Features a unique pattern of flashing. Each color lights up and dims and then the unit rapidly flashes each of the colors individually. These two cycles repeat themselves for a fascinating visual effect. Operate on 3VDC. This a beautiful attention getting display of colors!

**G16226 \$3.00 ea.**

All of the items below are currently on sale! Tremendous Savings on many popular items.

All Sale Prices & Special Promotional Offers Expire 01/31/07

## Electronic Goldmine SALE Specials!

### Color Video Camera with Audio

Compact CMOS color camera with audio comes complete with small 12VDC adapter. Features small 2.5" x 1.75" x 1.25" case, NTSC 510 x 492 picture element, electronic shutter, 1/60 - 1/15000 sec, 380TV lines, min illumination 3LUX, auto backlight compensation and adjustable focus lens. Has 3 female jacks. Brand new!

**G16163 ~~\$59.95~~ SALE! \$49.95 ea.**

### Low Light Black & White Video Camera with Audio

This compact 2.5" x 1.75" x 1.25" black and white video camera has 6 built in IR LEDs to illuminate objects up to 4 ft. away in a totally dark room. In normal lighting an adjustable focus lens allows for closeups or distant operation. Has built in microphone for audio and comes with a 12VDC power adapter. Has 3 female jacks. Brand new!

**G16159 ~~\$34.95~~ SALE! \$29.95 ea.**

### 60x-100x Zoom Pocket Microscope with Light

Handy pocket microscope has a zoom function and a built in white LED light. This powerful pocket microscope zooms from 60x to 100x. It features a switch to turn on the illumination, a removable microscope slide holder, and a focus knob. The size is only 5.75" x 1.8" x 1" (excluding microscope slide holder/stand). Brand new in attractive retail box. Requires two "AA" batteries (not included). Makes a great gift!

**G16179 ~~\$8.95~~ SALE! \$7.95 ea.**

## ATTENTION

As a special bonus for Nuts & Volts readers, go online to our search engine and enter: **NVJAN** for an exclusive offer!

### Beam Solar Panel 2.4VDC @ 20mA

Weather proof small encapsulated solar cell is sturdy and easy to use. Produces 2.4VDC open circuit voltage and 20mA short circuit current. Has pads on bottom side for easy solder connection. This reliable easy to use panel is only 1 5/16" x 15/16" and weighs only 2.5 grams -perfect for outdoor beam robotic designs! New from factory, part# RU2420.

**G16075 ~~\$3.49~~ SALE! \$2.75 ea.**

### 16VDC .120Amp 4" x 12" Glass Solar Panel with Wire Tabs

Compact yet powerful 4" x 12" solar panel has wire tabs to allow you to simply solder your hookup leads using standard rosin core solder. Output is 15 to 17VDC open circuit voltage and short circuit current is .110Amp to .140Amp. Great for battery charging and powering hundreds of electronic devices. New but may have slight cosmetic defects (edge chips, discoloration etc) -that will not effect output.

**G16129 ~~\$12.95~~ SALE! \$9.95 ea.**

### Tiny Inverter Transformer

Designed for tiny strobelights this small inverter transformer converts 3VDC into 200VAC when used with a simple 2 transistor circuit. Size only .4" square x .35"H. Has 4 pins. Comes with a schematic of a simple strobe using this transformer.

**G13599 ~~\$3.99~~ SALE! \$2.49 ea.**

### Super Breadboard

Compact breadboard for making prototype circuits features 60 groups of 5 connected terminal points. Each terminal firmly grips the lead or IC pin inserted into it. Reusable over and over again. Size: 3 1/4"L x 1 3/8"W. White plastic with peel and stick foam tape on base.

**G9849 ~~\$3.98~~ SALE! \$3.49 ea.**

### Super Sensitive Vibration/Shock Sensor

Vibration sensor designed for car alarms features a sensitive IC circuit with an adjustable sensitivity control to allow for super sensitive detection. At the highest setting the slightest tap sets it off. Has 2 built in LED indicator lights and can operate from a 9V battery or higher voltage up to 14VDC. Very simple to use - connect up power and connect output lead to relay, LED, SCR, etc. We give you a simple hookup diagram that shows how to hookup to any 5VDC DPDT relay (not included) to "latch on" after detection. Sensor board has a removable protective cover. Size about 2.4" L x 1.8" W x 1.25" H. Brand new and very unique.

**G15777 ~~\$2.49~~ SALE! \$1.99 ea.**

### VICOR FlatPAC 5VDC 40Amp Power Supply

Small footprint power supply by VICOR model VI-LU0-EU FlatPAC (LU Series) features an input voltage range of 100 to 240VAC and an output voltage range of 5VDC (regulated) at up to 40Amps (200Watts). Size only 9.25"L x 2.5"W x 1.37"H. Includes booklet from Vicor that contains Application Notes. Hookup info is printed on the top of the supply. Brand new and worth much more than our blowout price!

**G16217 ~~\$47.95~~ SALE! \$39.95 ea.**

\$10.00 Minimum Order + Shipping | Electronic Goldmine • www.goldmine-elec.com • 1-800-445-0697 • P.O. Box 5408, Scottsdale, AZ 85261

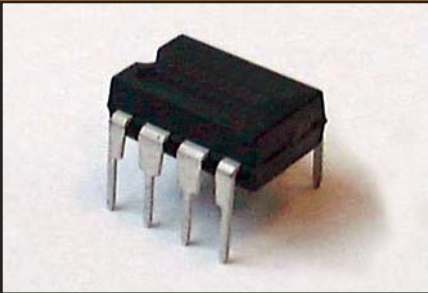


# Getting Started With PICAXE MICROCONTROLLERS

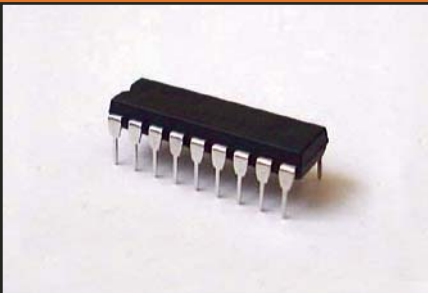
## PART 1

by Ron Hackett

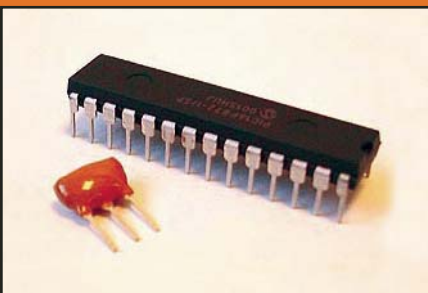
### The PICAXE-08M Chip



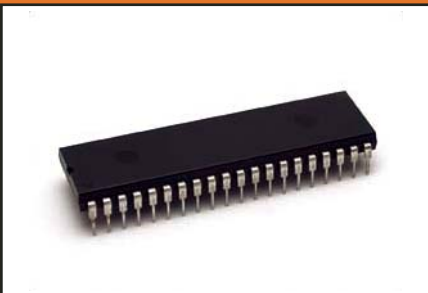
### The PICAXE-18X Chip



### The PICAXE-28X Chip



### The PICAXE-40X Chip



If you are relatively new to the world of programmable microcontrollers, the PICAXE line of processors is the perfect place to start, for three major reasons:

- 1) **PICAXE chips are programmed in BASIC** — no need to learn a complicated assembly language.
- 2) **PICAXE processors are surprisingly inexpensive** — from less than \$4 (yes, \$4!) for the amazingly small PICAXE-08M (with five I/O pins) to \$10 for the super-powerful PICAXE-40X (with 32 I/O pins).
- 3) **The PICAXE Programming Editor (the software you use to write, develop and download your program to a PICAXE processor) is free!** What more could you ask for?

On the other hand, if you already have some experience with programmable microcontrollers (possibly with the BASIC Stamp from Parallax or the BasicX from NetMedia), you still should take a look at the PICAXE chips. For example, let's say you have designed, breadboarded, and tested this great little temperature monitor and controller project and you're ready to put it into action. Do you really want to tie up a processor that may have cost you \$50 or more, or would you rather make a couple of minor changes to your software and actually construct it with a \$4 PICAXE chip?

As a means of introducing the PICAXE system, this three-part article will describe the development of a complete I/O terminal consisting of a matrix keyboard for input and an LCD character display for output. Most microcontrollers — including the PICAXE chips — have some form of I/O functionality using the serial connection to your PC, but sometimes it's helpful to be able to test and debug your program in situations where a PC is not available. Also, some programs require a fair amount of interaction with the user during program execution. Our I/O termi-

nal can function in either of these scenarios, and can be used with PICAXE, BASIC Stamp, and BasicX chips, or just about any system which supports five-volt level serial communications.

In this article, we will focus on the PICAXE-18X chip, which (in terms of size and power) is somewhere in the middle of the PICAXE line of processors, and costs less than \$8. It actually has many more features than we will need for our project, but it will also provide significant "room to grow" for future projects.

Part 1 of the article will provide a brief introduction to PICAXE programming by developing the simple, yet classic, "Hello World" program.

Part 2 will focus on interfacing the PICAXE-18X chip with a Hitachi HD44780-based LCD display, and providing a simple serial interface to the LCD. Of course, there are plenty of serial LCD displays you can purchase, but they tend to be an expensive item to dedicate to one project. On the other hand, Hitachi HD44780 displays are very inexpensive and readily available from electronics suppliers on eBay and elsewhere (see the Resources List for some suggestions). Their only drawback is that they

# Getting Started With PICAXE Microcontrollers

consume a minimum of six I/O pins, but with PICAXE chips also being so inexpensive, it's not a problem to switch from an 18X (14 I/O pins) to a 28A or 28X (21 I/O pins) when necessary, or even a 40X (32 I/O pins) if you want to control a significantly larger portion of your world!

In Part 3 of this series, we will add a small (12 or 16 key) matrix keyboard to complete our I/O terminal.

## Introduction to PICAXE Chips

PICAXE microprocessors are produced by Revolution Education — a British company dedicated to promoting the study of electronics and robotics in primary and secondary education. The PICAXE product line currently consists of eight Basic-programmable microprocessors ranging in size from eight to 40 pins. Each PICAXE processor is actually a Microchip PIC processor with a built-in Basic interpreter. Complete documentation on the hardware and software specifications of the PICAXE processors is available on the PICAXE website ([www.picaxe.co.uk](http://www.picaxe.co.uk)).

To get started, the most important datasheets to download are the three sections of the PICAXE manual: "Getting Started," "Basic Commands," and "Interfacing Circuits." These three datasheets — as well as a wealth of other useful documentation — are automatically included in the free download of the PICAXE Programming Editor software discussed below. All of the documentation is available under the "Help" menu of the Programming Editor.

PICAXE Basic is very similar to many other implementations of Basic (including Parallax's version for the BASIC Stamp I), so it is a very easy language in which to program. You can download a copy of my *PICAXE BASIC Summary for Beginners* from [www.JRHackett.net](http://www.JRHackett.net) to get an idea of the range of powerful commands available in PICAXE Basic. Section 2 of the PICAXE manual includes complete descriptions and examples of all the PICAXE Basic commands.

A brief summary of the features of selected PICAXE processors is pre-

sented in Figure 1. As you can see, the 18X can store a program of approximately 600 lines of Basic code, which is more than enough for just about any project. The Programming Editor software — which is the PICAXE IDE — is available free from the PICAXE website. It has a fairly full-featured graphical user interface and runs on Windows 95, 98, ME, NT, 2000, and XP. A Macintosh version of the software is not yet available, but the new Intel-based Macs can run Windows XP, so it's hopefully on the way!

The pin-out of the PICAXE-18X is presented in Figure 2; it has five input pins and nine output pins, the majority of which have multiple functions which are thoroughly discussed in the PICAXE manual. As can be seen in Figure 2, the PICAXE-18X does not include dedicated crystal or resonator pins. Instead, it has a built-in 4 MHz resonator, which is switchable to 8 MHz under program control. Of course, this arrangement frees up two of the 18X's pins for general-purpose I/O. However, an internal resonator is not as accurate as the external one found on the larger PICAXEs, but it is more than accurate enough for the types of tasks called for in most applications.

If your project does require more timing accuracy, there is a Basic command (calibfreq) that allows you to fine-tune the 18X's operating frequency. (Of course, you will need a frequency counter or oscilloscope to determine when you have it right.) Also, if you need more speed (and who doesn't?), the larger PICAXE

chips are capable of running as fast as 20 MHz with an external resonator.

## PICAXE Programming

Figure 3 presents a complete schematic for the three-wire PICAXE programming interface, which only requires two resistors (R2 and R3). An optional third resistor (R1) on the serout line helps by providing short-circuit protection on that line. A special programming cable is available from Revolution Education, but it is easy to wire a standard RS-232 nine-pin connector with the three required lines, as Figure 3 demonstrates. Also, in order for the 18X to operate, the reset line (pin 4) must be tied high with a 4.7K resistor (R4).

As you may have noticed back in Figure 2, the serial output programming pin can also function as a serial output line for your program to transmit data back to your PC. The Basic "sertxd" command can be used in your program to send text or data back to the Terminal Window of the Programming Editor software. This functionality can be very helpful when debugging a program. For example, you can monitor

|                          | PICAXE-08M     | PICAXE-18X      | PICAXE-24X      | PICAXE-40X      |
|--------------------------|----------------|-----------------|-----------------|-----------------|
| <b>Pins</b>              | 8              | 18              | 28              | 40              |
| <b>I/O Pins</b>          | 5              | 14              | 21              | 32              |
| <b>Input Pins</b>        | 1-4            | 5               | 0-12            | 8-20            |
| <b>Output Pins</b>       | 4-1            | 9               | 17-9            | 17-9            |
| <b>ADC Pins (10-bit)</b> | 3              | 3               | 4-0             | 7-3             |
| <b>PWM Pins</b>          | 1              | 1               | 2               | 2               |
| <b>Program Memory</b>    | 80 Basic lines | 600 Basic lines | 600 Basic lines | 600 Basic lines |
| <b>Storage Variables</b> | 48 bytes       | 96 bytes        | 112 bytes       | 112 bytes       |
| <b>Data Memory</b>       | 256 bytes      | 256 bytes       | 128 bytes       | 128 bytes       |

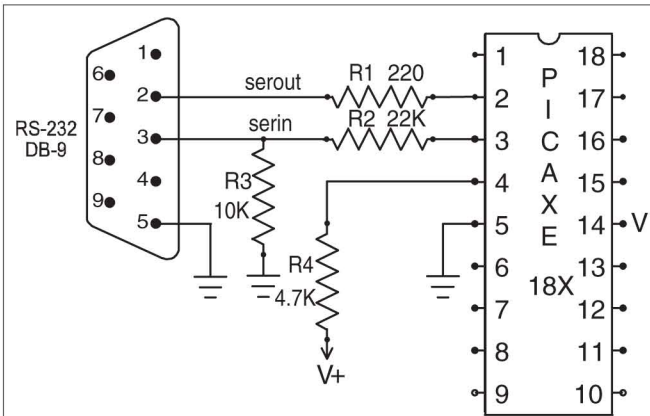
FIGURE 1. Features Summary of Selected PICAXE Processors.

FIGURE 2. PICAXE-18X Pin-out.

|                   |   |    |               |
|-------------------|---|----|---------------|
| In2/ADC2          | 1 | 18 | In1/ADC1      |
| SerTxd            | 2 | 17 | In0/ADC0/IR   |
| SerIn             | 3 | 16 | In7/Kbd data  |
| Reset             | 4 | 15 | In6/Kbd clock |
| Gnd               | 5 | 14 | +V            |
| Out0              | 6 | 13 | Out7          |
| Out1/i2c sda data | 7 | 12 | Out6          |
| Out2              | 8 | 11 | Out5          |
| Out3/PWM3         | 9 | 10 | Out4/i2c scl  |



# Getting Started With PICAXE Microcontrollers



**FIGURE 3. PICAXE-18X Programming Circuit.**

sidebar). Also, be sure to download the free PICAXE Programming Editor software from Revolution Education ([www.reved.co.uk](http://www.reved.co.uk)). There isn't space here to go into detail on how to use the software, but it's very intuitive and includes ample documentation.

For our simple "Hello World" exam-

ple, we are going to program the 18X to alternately blink two LEDs on outputs 6 and 7 (external pins 12 and 13). All PICAXE output pins are capable of sourcing or sinking a maximum of 25 mA, so LEDs can be directly driven; just be sure to include a 220Ω or 330Ω current-limiting resistor in the output circuit. Actually, if you look closely at the photograph in Figure 5, you won't see the current-limiting resistors because they are built into the LEDs I am using, which makes bread-boarding a little simpler. If you are interested in these LEDs, see the Resources sidebar.

The "Hello World" program (presented in Figure 6) is very simple and can be quickly typed into the Programming Editor software. PICAXE Basic is very similar to standard Basic, so you should be "up and running" in no time. In case you have been wondering, you can power the circuit

of Figure 4 using a regulated five-volt supply, but it will also function perfectly well with a supply consisting of three AA alkaline batteries. Of course, if other components in your circuit require a regulated five-volt supply, you don't have the choice. One cautionary note: NEVER try to power a PICAXE project with four 1.5V batteries — you could instantly fry the PICAXE!

## Troubleshooting

If your "Hello World" project runs properly — congratulations — you can skip this section!

If your program won't download to the PICAXE-18X, double-check the breadboard wiring (especially the download circuitry and power and ground connections to the PICAXE), and be sure you have selected the 18X in the Programming Editor's View-Options-Mode menu. If the program downloads successfully, but doesn't run as expected, check the breadboard wiring again (especially the LED-related circuitry). If you're really stuck, send me an email at [Ron@JRHackett.net](mailto:Ron@JRHackett.net) — describe the problem as fully as you can, and I'll see if I can come up with more specific suggestions.

## Combining Input and Output

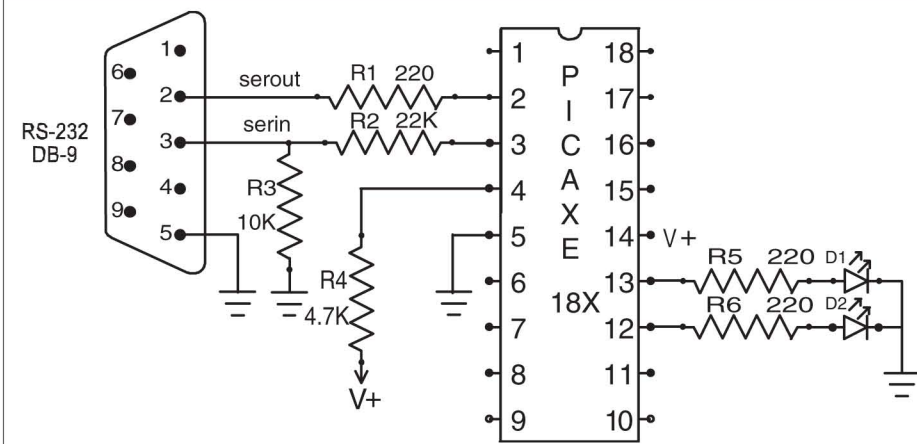
Now that "Hello World" is hopefully up and running, we're ready to jazz it up a little. One very important feature for many projects is for the program to be able to respond to user input. In order to do so, let's add an input button to our breadboard (as a precursor to the matrix keyboard of Part 3). Buttons are frequently problematic for

the changes in important variables as your program executes, and/or transmit back descriptive comments (e.g., "entering conversion subroutine") to help determine whether the program is functioning as intended. Used in conjunction with a simple push-button input, these techniques can allow you to "step through" your program one routine at a time in order to track down bugs and various logic problems.

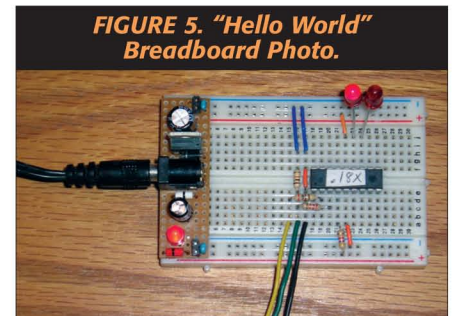
## "Hello World" Circuit and Program

As a brief introduction to PICAXE programming, let's start by breadboarding the "Hello World" circuit presented in Figure 4 and photographed in Figure 5. Of course, you will need a PICAXE-18X to actually implement the circuit, so you might want to take care of that before you continue (see the Resources

**FIGURE 4. "Hello World" Circuit.**



**FIGURE 5. "Hello World" Breadboard Photo.**



# Getting Started With PICAXE Microcontrollers

## RESOURCES

### PICAXE-18X

[www.phanderson.com](http://www.phanderson.com)

[www.picaxe.co.uk](http://www.picaxe.co.uk)

### Character LCD

[www.allelectronics.com](http://www.allelectronics.com)

[www.ebay.com](http://www.ebay.com)

[www.goldmine-elec.com](http://www.goldmine-elec.com)

[www.mouser.com](http://www.mouser.com)

### Matrix Keypad

[www.acroname.com](http://www.acroname.com)

[www.ebay.com](http://www.ebay.com)

[www.hvtech.com](http://www.hvtech.com)

### Five-volt Resistorized LED

[www.JRHackett.net](http://www.JRHackett.net)

```
===== HelloWorld.bas =====  
  
; This program runs on a PICAXE-18X processor at 4 MHz.  
; It alternately blinks LEDs on outputs 6 & 7 (pins 12 & 13).  
  
===== Constant Definitions =====  
  
symbol LED6 = output6 ; LED on output6 (pin 12)  
symbol LED7 = output7 ; LED on output7 (pin 13)  
  
===== Main Program =====  
  
main: high LED6 ; LED6 on  
      low LED7 ; LED7 off  
      wait 1 ; wait 1 second  
  
      low LED6 ; LED6 off  
      high LED7 ; LED7 on  
      wait 1 ; wait 1 second  
  
      goto main ; do it again, forever
```

FIGURE 6. "Hello World" Basic Program.

breadboards — their pins are usually too short or too fat (and sometimes incorrectly spaced) to fit properly in a breadboard. One solution to this problem is to solder short pieces of wire to each button pin and plug it in that way, but it can be difficult to press the button without holding it in the fingers of one hand and pressing with a finger of the other — a nuisance, to say the least.

Another solution is to solder the button to a small stripboard (the kind that has the holes connected by rows of copper traces on the bottom of the board), and then solder two small headers placed so that the header pins connect to the button pins. Figure 7 presents a diagram of such a board, and Figure 8 shows a photograph of the required parts (left side of photo), a right-side-up assembled board (upper right of photo), and an upside-down assembled board (lower right of photo) to demonstrate how the parts go together. It is important to note that the strip board is used "upside-down," i.e., when assembling the board, the copper traces are on top and all soldering (including the switch) is done on top of the board. If you want to, you can cut off the middle pin of each three-pin header since they are not connected to the switch.

A PICAXE input pin should always be connected either to V+ (high) or ground (low) in order to avoid possible excessive current drain resulting

from a "floating" input. You can set up your circuit so that the pin is high when the button is pressed and low when it is not pressed, or vice versa. Logically, it doesn't matter which way

you do it, but I prefer to hold the input pin low (with a 4.7K resistor to ground) when the button is not pressed and pull it high with the button is pressed. That way, high (one)

FIGURE 7. Push-Button Adaptor Diagram.

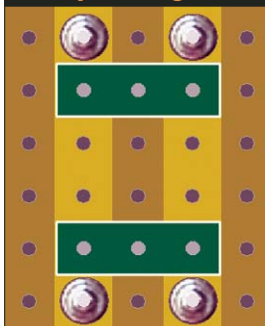


FIGURE 8. Push-Button Adaptor Photo.

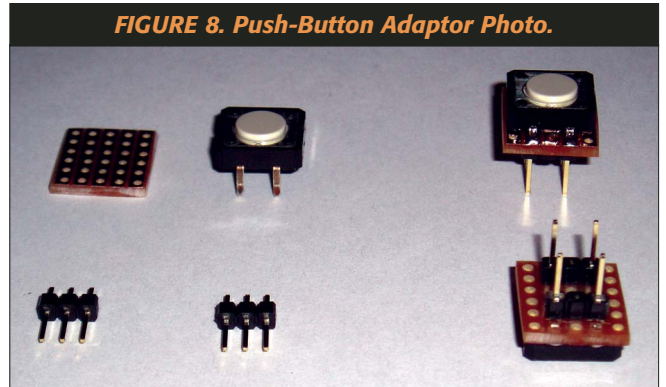
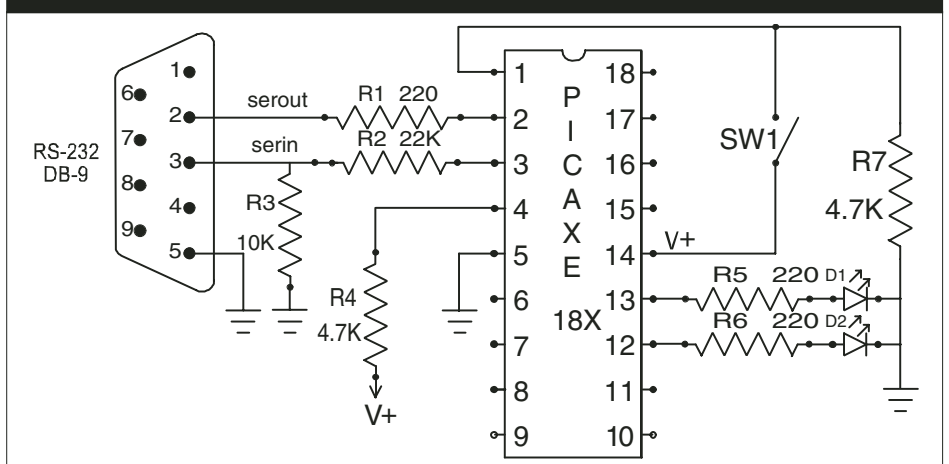


FIGURE 9. "Hello World" Button Circuit.





## Getting Started With PICAXE Microcontrollers

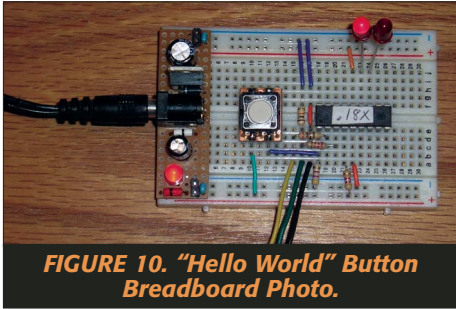


FIGURE 10. "Hello World" Button Breadboard Photo.

is on and low (zero) is off — it's just easier for me to remember.

We will add our button to the "Hello World" circuit by connecting it to Input 2 (PICAXE pin 1) as shown in Figure 9. The 4.7K resistor to ground holds the input low when the button is not pressed, while a button-press pulls the input high. Without the resistor, we would be creating a direct short

across the switch — not a good thing!

### LED-Toggle Challenge

Our goal in this second project is to be able to control the blinking of the two LEDs with the input switch; each time the switch is pressed, the LED that is currently lit should turn off and the other LED should turn on. Since we are running out of space this month, we will look at the actual program in Part 2 of this article. In the meantime, see if you can write a program that accomplishes our goal. PICAXE Basic includes a "button" command (see Part 2 of the PICAXE manual), but we aren't going to use it because it can't be used with the matrix keypad that will be introduced in Part 3 of this series. Instead, see if you can accomplish the goal without using the button command. Hint: If you are not already familiar with the phenomenon of "switch bounce," read page 26 in Part 3 (Interfacing Circuits) of the PICAXE manual before attempting to write the program.

### Conclusion

Next month, we will interface the PICAXE-18X with a 20-character x four-line HD44780-based LCD display, but you can also use a display of 16 characters by one, two, or four lines, with or without back-lighting. Of course, back-lighting greatly increases the power consumption, so it is probably not suitable for battery-powered projects. You may want to decide which size display you want to use and purchase one in advance (see the Resources List). If you want to build the entire I/O terminal, you should also have a small matrix keyboard (either 3 x 4 or 4 x 4) on hand, as well.

So, you have your work cut out for you; a programming homework assignment and a shopping list. See you next time! **NV**

### AUTHOR BIO

You can reach Ron via email at [Ron@JRHackett.net](mailto:Ron@JRHackett.net) or visit his website at [www.JRHackett.net](http://www.JRHackett.net).

### The Standard for checking Capacitors in-circuit



Good enough to be the choice of Panasonic, Pioneer, NBC, ABC, Ford, JVC, NASA and thousands of independent service technicians.

Inexpensive enough to pay for itself in just one day's repairs. At \$209, it's affordable.

And with a 60 day trial period, satisfaction guaranteed or money-back policy, the only thing you can lose is all the time you're currently spending on trying to repair all those dogs you've given up on.

#### CapAnalyzer 88A

Available at your distributor, or call 561-487-6103

Electronic Design Specialists

[www.eds-inc.com](http://www.eds-inc.com)

### Locate shorted or leaky components or conditions to the exact spot in-circuit

Still cutting up the pcb, and unsoldering every part trying to guess at where the short is?



\$209

Your DVM shows the same shorted reading all along the pcb trace. LeakSeeker 82B has the resolution to find the defective component. Touch pads along the trace, and LeakSeeker beeps highest in pitch at the defect's pad. Now you can locate a shorted part only a quarter of an inch away from a good part. Short can be from 0 to 150 ohms

#### LeakSeeker 82B

**GREAT ROBOTS. GREAT PRICES.**

**360° SENSOR TURRET**

FOR ULTRASONIC AND SHARP IR SENSORS

- 360 degree rotation!
- Works with Parallax and Devantech ultrasonic sensors AND Sharp infrared distance sensors
- Includes servo, all hardware
- Interchangeable sensor boards
- Rugged ABS plastic
- Easy to mount
- Versatile design
- Rubber shock mounts for ultrasonic sensor

Just \$19.95!

**BUDGET ROBOTICS**

[WWW.BUDGETROBOTICS.COM](http://WWW.BUDGETROBOTICS.COM)



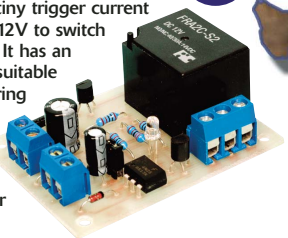
# Claw your way through our Catalog

Claw your way through our FREE copy of our 410+ page catalog, log onto our website [www.jaycar.com/catalog](http://www.jaycar.com/catalog) and get your copy. All prices in USD.

## DC Relay Switch

KC-5434 \$8.75 + post & packing

An extremely useful and versatile kit that enables you to use a tiny trigger current - as low as 400µA at 12V to switch up to 30A at 50VDC. It has an isolated input, and is suitable for a variety of triggering options. The kit includes PCB with overlay and all electronic components with clear English instructions.



## Galactic Voice Kit

KC-5431 \$26.25 + post & packing

Be the envy of everyone at the next Interplanetary Conference for Evil Beings with this galactic voice simulator kit. Effect and depth controls allow you to vary the effect to simulate everything from the metallic-challenged C-3PO, to the hysterical ranting of Daleks hell-bent on exterminating anything not nailed down. The kit includes PCB with overlay, enclosure, speaker and all components. For those who really need to get out of the house a lot more. Take me to your leader.

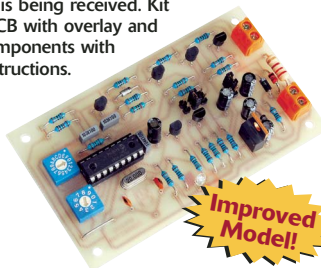
• Requires 9V battery



## Speedo Corrector MkII

KC-5435 \$29.00 + post & packing

When you modify your gearbox, diff ratio or change to a large circumference tyre, it may result in an inaccurate speedometer. This kit alters the speedometer signal up or down from 0% to 99% of the original signal. With this improved model, the input set-up selection can be automatically selected and it also features an LED indicator to show when the input signal is being received. Kit supplied with PCB with overlay and all electronic components with clear English instructions.



Improved Model!

## Radar Speed Gun

KC-5429 \$58.00 + post & packing

This Doppler radar gun reads speed in km/h or mph up to 250 km/h or 155 mph. It has a resolution of 1 km/h or 1 mph with an accuracy of 1%, and also has a hold switch so you can freeze the reading. There's a jiffy box to mount the electronics in, and the enclosure for the radar gun assembly is made from 2 x coffee tins or similar. Details included. Kit includes PCB and all specified components with clear English instructions.

• Requires 12VDC power



## Universal High Energy Ignition Kit

KC-5419 \$17.50 + post & packing

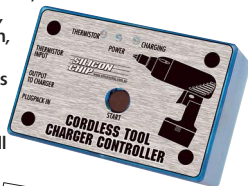
A high energy 0.9ms spark burns fuel faster and more efficiently to give you more power! This versatile kit can be connected to conventional points, twin points or reluctor ignition systems. Kit supplied with die-cast case, PCB and all electronic components.



## Powertool Battery Charger Controller

KC-5436 \$23.25 + post & packing

Enhance the performance of the charger supplied with your power tool with this controller. It incorporates charge timeout, min and max temperature monitoring, Delta V charge detection, power and charge LED indicator and more! Suits both Ni-Cd and Ni-MH cells. Kit includes PCB with overlay, case and all electronic components.



## POST AND PACKING CHARGES:

| Order Value      | Cost   | Order Value      | Cost |
|------------------|--------|------------------|------|
| \$25 - \$49.99   | \$7.50 | \$200 - \$499.99 | \$60 |
| \$50 - \$99.99   | \$20   | \$500+           | \$75 |
| \$100 - \$199.99 | \$40   |                  |      |

Max weight 12lb (5kg). Heavier parcels POA. Minimum order \$25.

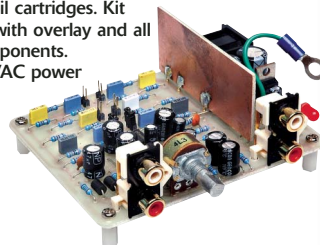
Note: Products are dispatched from Australia, local customs duty and taxes may apply.

## Magnetic Cartridge Pre-amp

KC-5433 \$23.25 + post & packing

This kit is used to amplify the 3-4mV signals from a phono cartridge to line level, so you can use your turntable with the CD or tuner inputs on your Hi-Fi amplifier. The design is suitable for 12" LPs, and also allows for RIAA equalization of all the really old 78s. Please note that the input sensitivity of this design means it's only suitable for moving-magnet, not moving-coil cartridges. Kit includes PCB with overlay and all electronic components.

• Requires 12VAC power



## IR Remote Control Extender MKII

KC-5432 \$14.50 + post & packing

Operate your DVD player or digital decoder using its remote control from another room. It picks up the signal from the remote control and sends it via a 2-wire cable to an infrared LED located close to the device. This improved model features fast data transfer, capable of transmitting Foxtel digital remote control signals using the Pace 400 series decoder. Kit supplied with case, screen printed front panel, PCB with overlay and all electronic components.



Requires 9VDC wall adaptor (Jameco #252751 \$12.05)

Improved Model!

Log on to  
[www.jaycar.com/catalog](http://www.jaycar.com/catalog)  
for your FREE catalog!

1-800-784-0263

(Monday - Friday 09.00 to 17.30 GMT + 10 hours only).  
For those who want to write: 100 Silverwater Rd  
Silverwater NSW 2128 Sydney AUSTRALIA

410+  
page  
Catalog

All  
prices in  
USD



# Jaycar

Electronics



# INTERFACING STANDARDS: RS-232

by Gerard Fonte

These days, there are various common interfaces available. Choosing the best interface is not always trivial. Do you need an interface to store data or to control your robot?

**W**e will be concentrating on the hardware aspects rather than the software, since this is usually the greatest problem for hobbyists. The main goal of this article is to provide enough basic information to allow the reader to successfully interconnect their own designs to a computer via the interface. However, there is a secondary goal as well, namely, to show how interfaces, in general, work. It will be seen that while there are dozens of interfaces, there are a few basic concepts that are repeated. Once these are understood, any interfacing design becomes a fairly straightforward process. What's more, you will be able to design your own custom interfaces that precisely suit your needs.

## Interface Classes

There are four general classes of interfaces based on two characteristics, as shown in Table 1. The first characteristic is whether the data is transferred on a single line (serial interface) or multiple lines (parallel interface). RS-232, USB (Universal Serial Bus), Firewire, and all wireless interfaces are serial. Centronics (printer interface), SCSI

(Small Computer System Interface), ISA (Industry Standard Architecture), and HP-IB (Hewlett Packard Interface Bus or IEEE-488) are parallel interfaces.

The second characteristic is whether the interface is a hardware or system interface. These names are functional descriptions rather than technical attributes, and some interfaces can actually fit in both categories. A hardware interface is very straightforward. All that you need to do is provide the proper timing, and the interface works. RS-232 and ISA are hardware interfaces.

System interfaces are different. They require both a hardware interface and a command interface, which usually means significant software (read computer) at the interface. A typical system interface is the HP-IB. There are only eight data lines and eight control lines (which is less complex than a printer interface). But the HP-IB interface has to understand commands sent on those lines. At the least, you have to recognize when incoming signals are commands. Otherwise, you will read commands as data and will get really fouled up. Additionally, with system interfaces, there are often multiple devices connected to a single interface. This adds another level of complexity because you will have to be sure the interface is talking to you and not someone else.

Additionally, you will have to have some means to determine if the interface is ready to listen when you talk.

The problem of two devices talking at the same time is not always easy to solve. Some system interfaces are extremely complex and require a serious computer at the interface. Bluetooth is such an interface. Other system interfaces are easier to work with. USB is much easier than Bluetooth but it is still much more complicated than RS-232.

## RS-232 History

Knowing some of the history of RS-232 and how it developed helps in understanding some of its characteristics. The first interface that enjoyed widespread use was the Baudot code. It was used by Western Union for their teletypes, which were the most common method of sending data (telegrams) by wire until the mid 20th century. This was a five-bit code that connected one teletype directly to another teletype. These machines were not electronic, they were completely mechanical. The surprising thing was that they actually worked fairly well, although slowly. They could operate at about five characters per second (roughly 60 words per minute). This is slower than a good typist, but a teletype could work 24 hours a day.

Five bits (32 different combinations) cannot directly incorporate all the letters, numbers, and punctuation of the English language. If they used 26 codes for the letters, they would have six codes left over. They created two different sets of 26 characters. One for letters and another for numbers, punctuation, and other miscellaneous symbols. Then they used two of the

TABLE 1. Basic categories of interface types. There are many other features and classes, but this breakdown is arguably the most fundamental.

|          | Hardware Interface | System Interface         |
|----------|--------------------|--------------------------|
| Serial   | RS-232, USB        | Firewire, Bluetooth, USB |
| Parallel | Centronics, ISA    | HP-IB, SCSI              |

TABLE 1

remaining six special “control” codes to identify which set was being used. If one control code was sent, everything following that code was from the first set. That is, until the second control code was found, then the other set was used. This is why there is a “control” key on present day keyboards. It’s a holdover from teletype keyboards.

This also explains why the word “stop” was often used instead of the period at the ends of sentences (as seen on many old movies). To create the period character, the operator had to press a control key, then press the period character, and then press another control key to resume alphabetic characters. This was awkward. And if either of the control codes was forgotten, the telegram data that followed would be nonsense. Typing “stop” took an extra character but was easier and carried no risk.

The remaining four control codes were Space, Line Feed, Carriage Return, and Null. Space was obviously used to separate words. Null was used mostly for testing. Line Feed causes the teletype to move the paper up one line. Carriage Return causes the teletype print head to return to the extreme left. Note that a Carriage Return without a Line Feed causes the print head to return to the beginning of the same line. This caused type-over. The carriage return function also took longer than printing a single character. So it was important to send a Carriage Return before a Line Feed if you wanted to start a new line. If you sent Line Feed and then Carriage Return, the paper would move up one space and then the carriage would start to move to the extreme left. But because it took more time, the first character after the Carriage Return would be “printed” during the

Carriage Return. This letter would appear (if it appeared at all) in the middle of the line and then get overwritten. Not a good thing. However, the convention of saying Carriage Return/Line Feed, rather than Line Feed/Carriage Return, remains today.

The old teletypes used current (typically 20 mA), rather than voltage, levels for communicating. With lines thousands of miles long, there was a lot of voltage noise present so this approach was appropriate. However, wires were prone to failure. Naturally, it was important to know immediately if there was a line problem. The solution to this problem was fairly simple. Instead of turning on a current only when you wanted to send information, you did the reverse. You kept the current on when no information was being sent (when

idling or waiting or “marking” time). You turned the current off to send data. In this way, if the wire failed, the marking current went away and it was clear that there was a problem. This results in the data being “inverted.” A logical “1” becomes zero current and a logical “0” becomes 20 mA of current. This characteristic of data inversion is still present in the modern RS-232 interface.

## RS-232 Today

The RS-232 interface was developed to allow modem (MODulator/DEModulator) communications over ordinary telephone “wires.” Being able to dial up a teletype or computer at will and without the need of dedicated wires is very useful. Note that telephone “wires” are not exactly the

| Pin Spec. | Name  | Full Name                  | Direction  | 25 Pin Computer | Nine Pin Computer |
|-----------|-------|----------------------------|------------|-----------------|-------------------|
| 1         | CGND  | Chassis Ground             | N/A        | 1               |                   |
| 2         | TX    | Transmit Data (from CPU)   | to modem   | 2               | 3                 |
| 3         | RX    | Receive Data (to CPU)      | from modem | 3               | 2                 |
| 4         | RTS   | Request to Send            | to modem   | 4               | 7                 |
| 5         | CTS   | Clear to Send              | from modem | 5               | 8                 |
| 6         | DSR   | Data Set Ready             | from modem | 6               | 6                 |
| 7         | SGND  | Signal Ground              | N/A        | 7               | 5                 |
| 8         | DCD   | Data Carrier Detect        | from modem | 8               | 1                 |
| 9         | TXCLP | + Transmit Current Loop    | to modem   | 9               |                   |
| 10        |       | Not used/open              | N/A        |                 |                   |
| 11        | TXCLN | - Transmit Current Loop    | to modem   | 11              |                   |
| 12        | SSD   | Secondary Signal Detect    | from modem |                 |                   |
| 13        | SCTS  | Secondary Clear to Send    | from modem |                 |                   |
| 14        | SDX   | Secondary Transmitted Data | to modem   |                 |                   |
| 15        | DCEC  | DCE Clock (modem)          | from modem |                 |                   |
| 16        | SRX   | Secondary Received Data    | from modem |                 |                   |
| 17        | RXC   | Receive Clock              | from modem |                 |                   |
| 18        | RXCLP | + Receive Current Loop     | from modem | 18              |                   |
| 19        | SRTS  | Secondary Request to Send  | to modem   |                 |                   |
| 20        | DTR   | Data Terminal Ready        | to modem   | 20              | 4                 |
| 21        | SQ    | Signal Quality             | from modem |                 |                   |
| 22        | RI    | Ring Indicator             | from modem | 22              | 9                 |
| 23        | DSRS  | Data Signal Rate Select    | either     |                 |                   |
| 24        | DTEC  | DTE Clock (computer)       | to modem   |                 |                   |
| 25        | TXCLN | - Receive Current Loop     | from modem | 25              |                   |

TABLE 2

TABLE 2. Complete definition of 25-pin RS-232 cable. Note that many of these signals are obsolete and no longer used. The pin numbers in the right-most columns refer to the standard PC serial port connectors.





## RS-232 Formats

The format of RS-232 data is quite variable (see Figure 3). There are four basic variables

that the transmitter and receiver must agree on: word length, parity, stop-bits, and baud rate. The word length can be anything from five to eight bits (remember five-bit baudot?). In nearly all applications nowadays, the word length is eight bits or one byte.

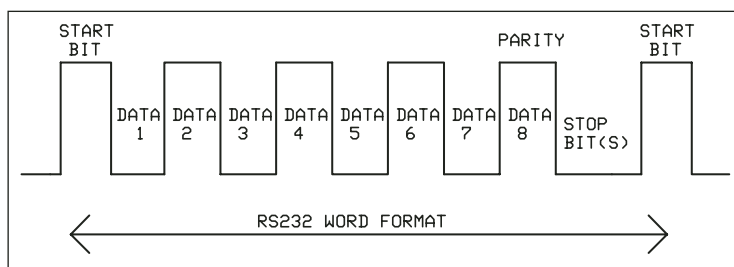
Sometimes, but not very often, parity is used. This is a simple error detection technique. A bit is added after the data to make the number of 1s in the data even or odd. If the receiver checks the data and finds that the number of 1s is not as specified, then there was an error in transmission. Some old systems require that the parity bit be part of the data word, instead of an extra bit. In this case, you will be limited to seven bits of data and a parity bit.

A computer generally has five options for setting parity: Even, Odd, Mark, Space, None. Even parity is when the parity bit is set to make the number of 1s an even number. Odd parity is when the parity bit is set to create an odd number of 1s. Mark indicates that the parity bit is set to a negative voltage. Space indicates that the parity bit is set to a positive voltage. None disables the use of parity and is the typical choice/default.

Added to every data word is a start bit and a stop bit. The start bit comes before the first data bit and is always high. The stop bit(s) are added to the end of the data and are always low. In this way, there will always be a low-to-high transition at the beginning of every transmission. This is useful because the receiver will ignore the data until a low-to-high is detected. So if the receiver is turned on in the middle of a string of data words, it will eventually find the beginning of a word and synchronize with the transmitter.

The number of stop bits is variable. Old mechanical systems required additional time to get ready for another word. Modern systems don't. Setting each stop bit to 1 is normal.

**FIGURE 3.** Basic format of RS-232 signal. Typically, there are eight data bits, a stop bit, and a start bit. If parity is used, it generally takes the place of the eighth data bit. There can be as few as five data bits and as many as two stop bits, but changing these parameters requires changing both the computer and modem interfaces. They can't be reset on the fly.



When you send and receive RS-232 data, your interface software will have to add or remove the start and stop bits as appropriate. They are not data.

The baud rate is the speed at which data is sent. The baud rate applies to a single bit of the whole word. The standard default rate is typically 9600, or 104.167  $\mu$ s per bit. This rate inherently defines the clock speed of the data. But speeds from 110 to 921,600 are available. With the exception of 110 baud, the standard rates are based on 150 baud, and rate doubles from there. For example, 150, 300, 600, 1200, 2400, 4800, 9600, and so on. Not all computer systems support all the rates. To determine what your computer supports and to set the values (for Microsoft Windows), go to: Start >Settings >Control Panel >System >Device Manager >Ports >COM1 (or COM2) >Properties >Port Settings.

A perpetual question is: How precise does your baud clock have to be? This is especially important when your system operates with a typical micro-processor clock of 4.000 MHz. You quickly find that 9600 into 4,000,000 won't go. You can't divide 4.00 MHz by any integer to get 9600.

To answer the question about clock precision, you first need to know that standard UARTs (Universal Asynchronous Receiver/Transmitters) use an internal clock that is 16 times the basic baud rate. Once the low-to-high transition is detected, they start this 16X clock, wait eight clock cycles, then read the data bits every 16 clock cycles thereafter. This places the "read" function in the middle of each bit.

There are eight data bits and a start and stop bit (typically) in each word for a total of 10 bits. It would seem, therefore, that your clock precision need only be  $\pm 0.5$  bits (or 5%) or better for the last bit to properly synchronize with the UART clock. But there is another error source. You

can't be sure of the alignment of the 16X clock with low-to-high transition. Alignment could be off by as much as  $\pm 0.5$  cycles of the 16X clock. This added error (worst case) reduces the maximum allowable clock error to 0.47%. This means that a rate between 9555-9645 baud will work with a standard 9600 baud UART and a 16X clock. Note that your interface should sample received data at 16X, as well.

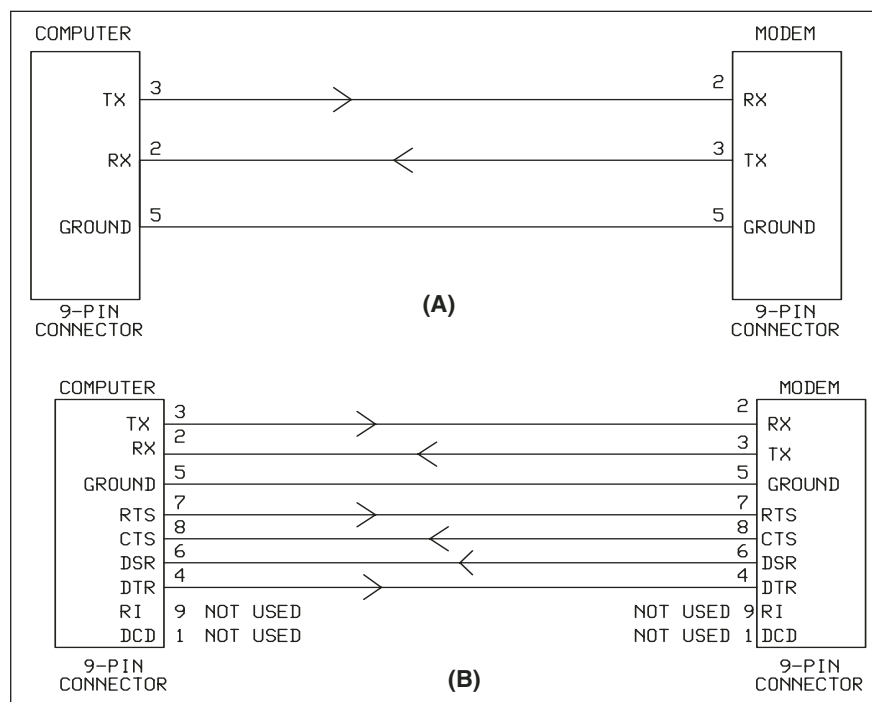
## Handshaking

The last consideration is handshaking. Handshaking is used when you need to be able to inform the other end of the interface that transmission or reception can take place. There are three basic forms: none, XON/XOFF, and hardware.

No handshaking means that there is absolutely no way of knowing if the receiver is ready to accept data. The data is sent regardless. If the receiver is not ready, or not even connected, the sent data is lost. However, this method (see Figure 4A) is by far the easiest. All you have to use is three wires: transmit, receive, and ground. If you are only sending data in one direction, only that wire and ground are needed. Note that the transmit wire from the computer goes to the receive wire of the modem and vice versa.

XON/XOFF is a software handshaking method. It also requires only three wires: receive, transmit, and ground (see Figure 4A). This approach takes advantage of the full-duplex operation of the RS-232 interface. Full-duplex means that data can be transmitted and received simultaneously. With separate transmit and receive wires, this is clearly possible. If the receiver (at either end of the interface) cannot handle more data from the transmitter, the receiver sends the XOFF character (013 hex) to the transmitter on the other line. The software recognizes this character and





**FIGURE 4.** The top drawing shows how to wire the simplest RS-232 interface. XON/XOFF requires all three wires to be connected. If no handshaking is used and data is only being transmitted or received but not both, only the appropriate transmit line and ground are needed. Full hardware handshaking is shown in the bottom drawing.

before the transmitter stops. Therefore, the receiver can't wait until the receive buffer is completely full before sending the XOFF character because it might lose a subsequent character due to transmitter delay. The second point is that care must be taken when you want to transmit data values that are the same as XON or XOFF. For example, if you are sending binary temperature values, and one value just happens to be 013 hex, you've just turned off the transmitter on the other end of the interface. And it will stay off until it gets the 011 hex value.

The last handshake method is with hardware (Figure 4B). Additional RS-232 lines are needed for this. The big problem

the transmitter stops. Once the receiver is ready, it sends the XON character (011 hex), and the transmitter resumes.

There are two important points to remember. The first is that software takes more time than hardware. This means that it is possible for one more full character to be sent

with RS-232 is that this "standard" has so many variations that it can seem as if there is no standard at all. We'll only examine the nine-pin connector, because it is extremely rare nowadays for any other type to be used. We've already discussed the transmit, receive, and ground signals. There are six more signals to consider.

DTR (Data Terminal Ready) and DSR (Data Set Ready) indicate (by high levels) that the computer and modem, respectively, are connected and ready to operate. Generally, these are held permanently high. They are used

## EMBEDDED LINUX STARTER KIT

### FEATURES INCLUDE:

- Linux 2.6 Kernel
- 486-133 MHz based SBC
- 10/100 Base-T Ethernet
- Removable Flash Disk
- 32MB RAM
- Power Supply
- Carrying Case
- Starting at \$399.00
- X-Windows (option)
- Eclipse Development Package



Imagine running Embedded Linux on a Single Board Computer (SBC) that is 4.0" x 5.7" and boots Linux from a Flash-Disk. No harddrives, no fans, nothing to break. Now your hardware can be as reliable as Linux! If your application requires video output, the X-Windows upgrade option provides video output for a standard VGA monitor or LCD. Everything is included; Ready to Run Linux! For more information, please visit our website at: [www.emacinc.com/trainers/linux\\_starter\\_kit.htm](http://www.emacinc.com/trainers/linux_starter_kit.htm)

Since 1985  
OVER  
21  
YEARS OF  
SINGLE BOARD  
SOLUTIONS

**EMAC, inc.**  
EQUIPMENT MONITOR AND CONTROL

Phone: (618) 529-4525 Fax: (618) 457-0110 [www.emacinc.com](http://www.emacinc.com)

## Baud Rate Versus Bits Per Second

Baud rate is often used interchangeably with bits-per-second (bps), however they are not the same thing. Baud rate refers to the physical ability of a medium to change state (transition rate) whereas bps refers to the amount of information that can be transferred. Sometimes the baud rate and the bps rate are the same, but most often they are not. The technically-correct way to specify RS-232 speed is as baud rate.

It's clear that one can choose by fiat to use any series of signals to represent a binary value of one or zero. If the choice is to use "101010101" to represent a logical "1" and "010101010" to represent a logical "0" we see that it takes nine transitions to represent a single bit (Binary digit). In this case, the baud rate is nine times greater than the bit rate.

It is also possible to have a bit rate in excess of the baud rate. This can be accomplished by encoding the data using multiple signal parameters. The most obvious example of this is with high-speed modems that operate at 56 kbps over ordinary telephone lines. Regular telephone lines are typically limited to 3,000 Hz (or 3,000 baud). This provides a possible bit rate of more than 18 times the baud rate.

Since bps rate depends upon the encoding methods and the arbitrary definition of what "information" is, it is usually the improper term to use when describing interface speed. The term baud rate is more accurate because it actually refers to the physical characteristics of the medium. Nearly all non-RS-232 interface specifications are rated as bps (or bits/sec), which we see as being technically incorrect. Unfortunately, it does not seem likely that interface specifications are going to change anytime soon.

more as hardware presence indicators rather than data-flow control. They primarily indicate whether the cable is attached properly and whether power is available to the computer and modem. If either of these lines fall to a low level, data transfer stops.

RTS (Request to Send) and CTS (Clear to Send) are the true handshaking lines that control the data flow. Their operation is very simple and straightforward. When the computer has data it wants to send to the modem, it sets the RTS line high. Basically this is asking the modem, "Are you ready?" If the modem is ready and able to receive data, it will set the CTS signal high to signal, "Yes, I'm ready." At this point, the computer sends data to the modem. If, at any time, the modem ceases to be able to handle the data, it sets the CTS signal low. The computer will then stop sending data until the CTS signal goes high. When the computer has finished sending data, it sets RTS low. The modem responds by setting CTS low.

Note that this data transfer is oriented from computer to modem. This made sense when it was initially developed because there was no such thing as a microprocessor at that time. The modem had no "smarts" and was just an analog/digital interface. Therefore, it was assumed that the computer end of the interface would control the interface.

Since the RS-232 interface is bidirectional, there must be a means for handshaking when the modem is sending data to the computer, as well. In this case, only one line is used — the RTS line. If the computer cannot maintain the data reception from the modem, it pulls the RTS line low to tell the modem to stop sending data. Thus, the RTS line must be high to allow data to be transmitted from the modem to the computer. Since the "computer side" of the interface is in control, the need for a second handshaking line is eliminated.

The last two signals on the nine-pin connector are status lines, rather than handshaking lines. They are DCD (Data Carrier Detect) and RI (Ring Indicator). These are associated with telephone signals and are not necessary for data flow or data control. Way back when, having a separate line to indicate when the target telephone was ringing was useful. Identifying

when the target modem came online by its carrier signal was also useful. However, nowadays there is little use for these signals as separate lines. They are rarely used and not necessary.


## Conclusion

RS-232 is the oldest true electronic interface standard that was, and still is, widely used. It has a number of features that are currently obsolete. Nevertheless, it is still a very useful and

## Recommended Books

- *The PC Handbook*, by John Choisser and John Foster, Annabooks, San Diego, CA ([www.annabooks.com](http://www.annabooks.com)).
- *PC Hardware Interfaces, A Developer's Reference*, by Michael Gook, A-List, LLC, Wayne, PA ([www.alistpublishing.com](http://www.alistpublishing.com)).



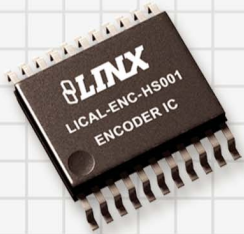
very common data-exchange interface. It is one of the few interfaces with which you can easily trade off speed for distance. RS-232 allows communications of up to a kilometer or more. **NV**




# A new era of secure RF

The ultimate in security for RKE and remote control applications. The HS Series transfers the status of up to eight buttons via a highly encrypted transmission.


CipherLinx™ security technology  
Never sends the same data twice  
Secure data authentication  
Up to 8 inputs  
Never loses sync  
80-bit key  
ISE evaluated  
Easy user setup



"In short, the CipherLinx™ protocol in the HS Series is well-designed and is an excellent choice for applications requiring a secure unidirectional link."



(Independent Security Evaluators)



**800-736-6677**  
**159 Ort Lane**  
**Merlin, OR 97532**

Visit [www.CipherLinx.com](http://www.CipherLinx.com) for more information.



# ALL ELECTRONICS

C O R P O R A T I O N

**QUALITY Parts**  
**FAST Shipping**  
**DISCOUNT Pricing**

CALL, WRITE, FAX or E-MAIL  
for a FREE 96 page catalog.  
Outside the U.S.A. send \$3.00 postage.

## 15MM PIEZO DISC

AVX # KBS-15DA-9C-31. 2" pigtail leads.  
CAT# PE-53

**75¢**  
each

10 for 65¢ each  
100 for 50¢ each

## 12 VDC 97 MM CENTRIFUGAL BLOWER

AVC # F9733B12LT. 12 Vdc, 0.72 Amp, ball bearing blower. 97 mm x 95mm x 33mm (3.80" x 3.73" x 1.3"). Four 11" leads with 4-pin socket connector, 0.1" centers. Two of the leads are part of a trigger-terminal mechanism for switching the blower remotely. The remote switch is easily bypassed by connecting the red and yellow leads together and the black and white leads together. See spec sheets on our web site for more hook-up information. UL, CSA, CE, TUV. CAT# CF-270



10 for \$5.00 each

**\$5.50**  
each

## 18 AMP SOLID-STATE RELAY, 3-15VDC CONTROL

Crydom # EZ240D18. Control Voltage: 3-15 Vdc. Output: 18 Amps @ 240 Vac. SCR output, low leakage solid state relay. 1.72" x 1.5" x 1.02" high including 0.25" QC/solder terminals. Mounting holes on 2.2" centers. UL, CSA, CE.



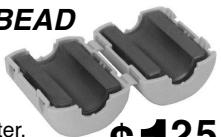
CAT# SRLY-18

10 for \$9.25 each

**\$10.50**  
each

## FERRITE SPLIT BEAD

Self-locking plastic snap sleeve holds ferrite form in place. 0.43" I.D. 1.33" long x 1.05" diameter.



CAT# FB-66

10 for \$1.00 each • 100 for 75¢ each

**\$1.25**  
each

## CCD IMAGE SENSORS

In digital imaging and photography Charge Coupled Devices (CCDs) capture light on their surfaces which is converted into images. These CCDs are, in effect, digital cameras without lenses. We have two types, both made by Sharp Electronics. We don't have documentation, but both are new and should be functional.

Sharp # YH9GB1.

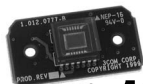
Consists of two pc boards, back-to-back. Overall size, 0.84" x 1.55" x 0.7" thick. CAT# CCD-1



**\$2.50**  
each

Sharp # YH9TM1.

Single pc board made for 3Com Corp. 1.2" x 0.65" x 0.34" thick. CAT# CCD-2



**\$1.25**  
each

## 6 VOLT, 1.3 AH BATTERY

Maintenance-free, rechargeable sealed lead acid battery. Can be used in any position and can be trickle charged for long periods of time. 3.85" x 2.10" x 0.98." 0.187" qc / solder terminals. New batteries, prepped with easily removable 2.5" wire leads with qc connectors. CAT# GC-613

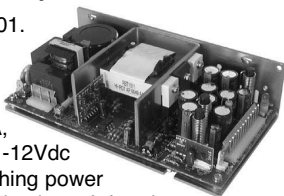


**\$4.75**  
each

## POWER SUPPLY, 5V/8A, 12V/2A, -12V/2A

Astec # RBT101.

Input: 115/230 Vac. Outputs: 12Vdc @ 2.0A, 5Vdc @ 8.0A, -12Vdc @ 2.0A. Switching power supply on an aluminum L-bracket, 6.78" x 3.65" x 1.72". UL, CSA, TUV. CAT# PS-105



**\$7.50**  
each

## 12VDC 1000MA WALL TRANSFORMER

Input: 120V 60Hz 25W. Output 12 Vdc 1000 mA. Screw Terminals. UL listed.

CAT# DCTX-121

**\$6.75**  
each

10 for \$6.00 each



## 30" USB EXTENSION CORD

USB-A male to USB-A female. 30" extension cord. Ideal for use with USB memory sticks and other direct-plug-in devices.

CAT# CB-393

**\$1.75**  
each

10 for \$1.50 each  
100 for \$1.15 each



## MINI-GEARHEAD MOTOR, 166:1 RATIO

Portescap (escap) Motor 17 N 78 213E 1 Portescap (escap) Gearhead R16 6 166 Precision, Swiss-made motor and gearhead. Quiet, smooth-running. Lots of torque for its size. 48 RPM @ 7.5 Vdc @ 21 mA. 17mm diameter x 50mm long (excluding shaft). 3mm diameter x 8mm long flattened shaft. Solder lug terminals.



CAT# DCM-285

**\$17.75**  
each

## 2.1MM DC POWER JACK

Normally closed shunt opens when plug is inserted. Mates with coaxial power plugs with 2.1" diameter centers. Solder lugs.

CAT# DCJ-1

**35¢**  
each

10 for 30¢ each  
100 for 19¢ each  
500 for 16¢ each  
1000 for 12¢ each



Shop ON-LINE [www.allelectronics.com](http://www.allelectronics.com)  
ORDER TOLL FREE 1-800-826-5432

MAIL ORDERS TO:  
ALL ELECTRONICS CORP.

14928 OXNARD ST., VAN NUYS, CA 91411-2610

FAX (818) 781-2653 • INFO (818) 904-0524

E-MAIL [allcorp@allcorp.com](mailto:allcorp@allcorp.com)

NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D. • Shipping and Handling \$7.00 for the 48 Continental United States - ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

**MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.**





# ELECTRONET

>>>> go to [www.nutsvolts.com](http://www.nutsvolts.com) — click Electro-Net <<<<

Long-range Wireless Modules

**MaxStream.  
Do the Math.**



Toll Free 866.765.9885  
[www.maxstream.net](http://www.maxstream.net)



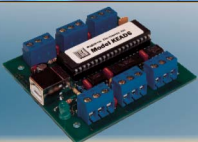
Compiler Evolution, Next Generation  
C Solution . . . Version 4..



Custom Computer Services, Inc.  
[www.ccsinfo.com/picc](http://www.ccsinfo.com/picc)  
262.522.6500

(Enter code: NVV4 for \$10 off your next purchase.)

**POTENTIOMETER  
TO KEYSTROKE  
CONVERTER**



**HAGSTROMELECTRONICS.COM**

**OBD2CABLES.COM**

- Thousands of OBD cables and connectors in stock
- Custom cable design and manufacturing
- Lowest prices
- Order Online: [http://www.obd2cables.com](http://http://www.obd2cables.com)



**ramsey**  
[www.ramseykits.com](http://www.ramseykits.com)

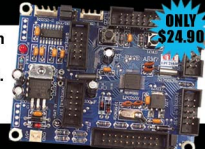
AM/FM Broadcasters • Hobby Kits  
Learning Kits • Test Equipment  
...AND LOTS OF NEAT STUFF!



**CONTROLLERS**

NEW ARM2103 Controller

Includes LPC2103 Microcontroller, Direct In-Circuit Program Download and Update, Easy to connect Port Connections, Delivered Ready to Run, Ideal for Robots and Control Systems. Also Available: ARM7024 Controller, ATMEGA8535 Controller, and PIC16F877 Controller



[www.futurlec.com](http://www.futurlec.com)

**Sheet Metal Fabrication**



**Complete Fabrication Center**  
Integrated Ideas & Technologies, Inc.  
Precision Laser, Waterjet, Plasma, Machining,  
Forming, and Welding Capabilities  
[www.iitmetalfab.com](http://www.iitmetalfab.com)

**USB** Add USB to your next project—  
it's easier than you might think!



- USB-FIFO • USB-UART • USB/Microcontroller boards
- RFID Reader/Writer • ZigBee Ready Transceivers

[www.dlpdesign.com](http://www.dlpdesign.com)

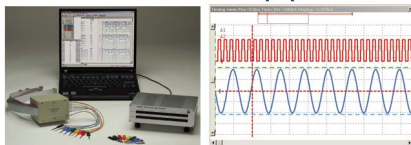
*Absolutely NO driver software development required!*

**Link Instruments**

PC-Based Test Equipment

Digital Oscilloscopes  
Logic Analyzers

[www.Linkins2.com](http://www.Linkins2.com)  
973-808-8990



**ZigBee™/802.15.4 Kit**

For low-cost and  
low-power wireless  
control networks.

**\$299**  
reg \$399  
limited offer

[www.rabbit4wireless.com](http://www.rabbit4wireless.com)



Robotics at your service!™  
[www.robotshop.ca](http://www.robotshop.ca)

A new era of secure RF

[www.CipherLinx.com](http://www.CipherLinx.com)



**ELECTRONIC  
GOLDMINE**  
[www.goldmine-elec.com](http://www.goldmine-elec.com)  
Visit Us Online!

100+ Electronic Kits  
and Modules  
[www.TechnologyKit.us](http://www.TechnologyKit.us)

**IntelliBrain™-Bot**



- Java™ programmable
- Example programs
- Tutorials
- IntelliBrain controller available separately

[www.ridgesoft.com](http://www.ridgesoft.com)

**Technological Arts**  
Adapt9S12XDP512 is here!  
[www.technologicalarts.com](http://www.technologicalarts.com)  
Toll-free: 1-877-963-8996



**Beta**  
LAYOUT  
TOLL FREE  
1877 3908541

**PCB-POOL**  
[WWW.PCBPOOL.COM](http://WWW.PCBPOOL.COM)

Price Example: 16 Sq-Inches, (ds - pth)

**2 Days: \$ 90**  
**8 Days: \$ 22.5**

**electronic surplus inc.**  
5363 Broadway Ave  
Cleveland, OH 44127  
Voice: 216-441-8500  
Fax: 216-441-8503  
[ELECTRONICSURPLUS.com](http://ELECTRONICSURPLUS.com)



trical installation employing house current carries a fire risk. The consumer must weigh the danger of having no heat in an emergency against their ability to install a UPS safely.

Yes, there are conventionally approved ways to set up "entire-house" power sources. I have one in my house. It does require a mains disconnect as Mr. Saladino describes. This project does not feed power back into the house mains so it does not require this treatment.

I would further suggest you do not leave your furnace fan permanently connected to a UPS. Connect the UPS only if you are having a power-out weather emergency, and life is threatened by low temperatures.

Kenton Chun

## WELL, WELL, WELL ...

I really liked Kenton's article in the December issue. In the article, he refer-

enced making sure to not try using it on a 220/240V well pump. I thankfully have a heat-producing fireplace but I also have a well. When my electricity goes out, I lose all water pressure. I have some water stored in two-liter pop bottles which is not a good solution. I know that a lot of people have wells. I would sure like a follow-up of how to best do the same for 220/240V.

I really like your magazine.

Mark

## Atmel AVR based Micro64/128 Embedded Controller Module

- 8-Channel Analog to Digital Convertor
- Real Time Clock/Calendar
- 29 Digital I/O
- SPI & I<sup>2</sup>C Bus
- Two Serial Ports
- Serial Boot Loader
- RS-232, 422 or 485
- Selectable Baud Rates up to 250 Kbps
- Only 1.5 Cubic Inches
- Supports Assembly, BASIC and C Prog. Languages
- Inexpensive CodeVision C Compiler



Starting at Only  
**\$119** - Single Qty



## Start Developing

The Micro6/128 Development Board takes the Micro64/128 I/O pins and expands them out to solder pads and headers for ease of connection when developing. It also connects USART1 to RS-232 drivers or directly to screw terminals for RS-422 or RS-485 communication. USART0 is also connected to RS-232 drivers. The RS-232 drivers are connected to two DB9 connectors. This board includes a prototyping area so the user can add external circuitry. There is an onboard voltage regulator for powering the Micro64/128 and additional circuitry. The Micro64/64A/128/128A development system comes complete with a Micro64, Micro64A, Micro128 or Micro128A, a Micro64/128 Development Board, and a power supply.

**VISIT WWW.MICROMINT.COM FOR MORE INFORMATION or Call 1-800-635-3355**

## BIG "MISTEAK"?

The November issue, page 8, reported the Earth's magnetic field at "a mere 31T." Nothing more about that! I could believe 0.000031T (31uT), a million times less. If you make a goof, make a big one I always say, it's easier to find.

Thomas S. Ely, MD  
Bloomfield, NY

## A LIGHT CHALLENGE

In regards to your TechKnowledgey 2006 column of November ...

As much as I would like your affirmation on LEDs being much more efficient light sources than fluorescent devices to be true, I believe it is greatly misleading.

I urge you to read the document. (<http://www.netl.doe.gov/ssl/PDFs/LED-FAQ.df>)

I put you to the challenge of conveniently lighting a room with LEDs and use less energy than fluorescent devices.

I am not even talking about price of acquisition or even deployment.

There are no secrets, a fluorescent still puts out more omnidirectional light, consumes less energy to do it, and costs much less than any LED on the market today.

Please convince me otherwise as I have been looking for a long time and still have not found any practical omnidirectional LED lighting.

The only places the LED shines right now is in directional applications: flashlight, traffic lights, car back lights, and flashers.

Michel Charest  
L'Assomption, QC Canada  
Continued on Page 70

Got excess electronic inventory? Send us your list or give us a call, we'd be happy to make an offer!

Call 1-800-4-HALTED (1-800-442-5833) to order...

...or use our web search! Deals @ HSC!

Search

### Electro-Hobbyist Alert -- HSC is your source!

Even before there was a place called "Silicon Valley", HSC was the favorite stop of hardware hackers, techno-tinkerers, entrepreneurs and engineers on a budget! We have been buying and selling the Valley's excess inventory for 40 years now, and our collection is second-to-none! We are also factory-authorized distributors for many fine lines of parts, tools, equipment and accessories, so we feel we should be your first stop when shopping for electronic basics. Give our ever-expanding website a try and see what we mean!



Fujitsu Laptop Power Supply  
16VDC, 3.75 A, Fits many models

HSC#21183 \$24.95



USB 2.0 to IDE Drive Adaptor

HSC#80822 \$14.95



2.4 GHz Wireless Color Security  
Camera with Receiver

HSC#80830 \$37.50



700MHz Transceiver  
Hobbyist Special!

HSC#21067 \$19.95



USB External 2.5" Metal Drive Case

HSC#80824 \$14.95

2.5" 30GB Laptop IDE Hard Drive  
for above case (not shown)

HSC#21248 \$39.95

**Special! Buy both  
case and drive above  
for \$49.95!**



Slo-Syn Stepping Motor  
Model SS-25, 120V, .3A

HSC#20725 \$26.95



Vicor 48VDC 2.1A Flatpac Supply

HSC#80849 \$27.50



RF Transistor Engineering Kit  
54 different devices

HSC#20999 \$29.50



Universal Laptop Power Supply

HSC#80844 \$37.50



29.4 GHz Transceiver  
with 12" dish -- Wow!

HSC#21154 \$95.00



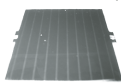
Pressure Transducer, 0-30 psi

HSC#21066 \$9.95



Plantronics LS1 Computer Headset  
(Stereo & mic. plugs, not RJ-11)

HSC#20948 \$12.50



Solar Panel 4.7 - 5.0 VDC, .25W  
60 x 60 mm, CuInSe

HSC#80821 \$4.95



"Backpack Bantam"  
Parallel-port external CD ROM

HSC#20972 \$19.95



Toroidal Transformer, 70VCT, 1A

HSC#20691 \$14.95



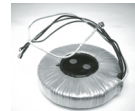
PCMCIA FireWire card

HSC# 20830 \$12.50



Logitech QuickCam Express

HSC#21061 \$19.50



Step-down Toroid Transformer  
240 - 120 VAC 250VA

HSC#21058 \$35.00



Embedded Wireless Transceiver!  
2.4GHz - 200mW, 5VDC

HSC#21001 \$65.00



Wireless RF Transmitter  
for iPod

HSC#80837 \$12.95



5-port USB Host Card

HSC#80834 \$14.95



Small DC Gearmotor  
6 - 12 VDC, 3 - 6 RPM

HSC#80812 \$12.95



PCMCIA DVD/MPEG Video Card

HSC# 20829 \$12.50



TrippLite Outlet Strip, 5 ft. long

HSC#20794 \$39.95



Hands-free Cell-phone Headset  
2.5mm plug fits many phones

HSC#21118 \$2.95



Peltier Module - Electrocooler!

HSC#80813 \$24.95

### Homeboxx for Modern Home-Wiring!



- ◆ Extensive line of modularized home data, telco & audio wiring hardware
- ◆ Surface or built-in cabinets
- ◆ New product...search on "Homeboxx"

See Website for Details!

### Another Transceiver Hacker Special!



- ◆ S & C Electric "IntelliCAP Plus"
- ◆ Wireless Power Dist. Controller
- ◆ Dandy weatherproof enclosure
- ◆ 900 MHz Data Radio
- ◆ Yagi Beam Antenna (weatherproof)
- ◆ Coaxial Cable with "N" connectors
- ◆ Sold for experimental purposes only!
- ◆ Never used...no other info avail!

HSC#21177 \$149.00

### Fujitsu PenCentra Tablet Computer - Good to Go!



- ◆ Fujitsu PenCentra 130 computer
- ◆ 131 MHz NEC VR4121 MIPS CPU
- ◆ 32MB DRAM, 24MB ROM, 8MB Flash
- ◆ Color DSTN Touch LCD 640 x 480
- ◆ PCMCIA, VGA, PS2, USB, SIO ports
- ◆ Win CE 2.11 Pro in PROM (no disks!)
- ◆ Microsoft Pocket Office, Outlook, IE
- ◆ "Radio Ready" for LAN/WAN PC Card
- ◆ Internal microphone, speaker & jacks
- ◆ Stylus, Mini Keyboard, Dock & PS
- ◆ New, never used, 90-day warranty!

HSC# 80797 \$159.00



## Writer Response:

It might have been better to omit the word "much" in the opening sentence, at least with regard to fluorescents. But there has been notable progress in LED technology this year, and the referenced Department of Energy brochure is somewhat behind the times in rating white LED efficiency at 45 to 50 lm/W maximum. Back in March, Japan's Nichia Corp. announced a white LED that provides 100 lm/W, and last month Cree,

Inc., began marketing one that is said to produce up to 160 lm/W at 700 mA. As to directionality and cost issues, sure, LEDs are impractical for many applications. But the DoE's Solid-State Lighting Program is aimed at fruition in 2025, and a lot can happen in 18 years.

Jeff Eckert

## PIC-ing A POWER SUPPLY

I really enjoyed Chuck Hellebuyck's

PIC Hardware Interface article in the November issue. Keep more of these kinds of articles coming! As a rookie, I'm also very interested in how I should power my PIC projects. One example — I want to use a PIC-based system to switch a 110 VAC outlet. I'd prefer to build my project so it plugs into the wall and uses that power for both the switched outlet and the PIC itself. I know "power supply" is the answer, but there are so many options and I know so little.

Mark Abreu  
Wilmington, NC

I'll keep that idea in mind for a future article. Thanks for the feedback.

Chuck Hellebuyck

## THE GRAVITY OF THE SITUATION

The December 2006 edition of N&V contains instructions for building an east-west compass. The article states that if you found yourself aboard the International Space Station, you would be in zero gravity. This is categorically untrue. Gravity is what holds the space station (or any satellite) in orbit around the Earth. If you found yourself aboard the International Space Station, you would be in constant free fall.

Donald Smith

## TUBE TIED

I really enjoyed your vacuum tube articles in the November issue of N&V. Although I manage a multidiscipline engineering department in a high-tech company making state-of-the-art optical sensors with embedded digital systems, my hobby is vacuum tube audio and vintage radio restoration. I've done several projects like the Philco PT-44 you reported on, restored a couple of 1960's AM/FM tube receivers, and also designed and built tube-based audio amplifiers.

Would it be possible for N&V to host a permanent "tube section" for people like me? We'll still read the advertisements!

Roger Jones  
P.Eng, SMIEEE  
Toronto, Canada

8/16-bit EEPROM | Ser. EEPROM | Flash EPROM | GAL / PALCE | Most MCU's | Low Voltage to 1.3V. | DIL dev. w/o Adapter.

Conitec's last generation Galep-4 employs ASIC universal pin technology for each pin of 40 pin ZIF-socket. **9000+device library**/lifetime free updates. Programs 8/16 bit EPROM'S, EEPROM'S, 0-Pwr RAM, FLASH, Serial EEPROM'S, GAL, PALCE,

microcontrollers such as 87/89xxx, PIC, AVR, ST62, etc. Low voltage devices down to 1.3V. No adapter required for DIL devices. 8 Hrs. operation on battery (AC charger included). Runs **WIN 98,NT,ME, 2000, XP** with Hex/Fuse Editor.

Remote control from other apps, (e.g. VisualBasic). Substitutes high priced universal programmers e.g. ALL-11 (HILO) or LAB-TOOL-48 (ADVANTECH) Providing virtually matching performance at only 1/3-1/5 the price. Info, orders, softwr : **619-462-0515**

## A PALM-SIZED PROGRAMMER HANDLES OVER 9000 DEVICES ?

ISO 9001:2000 CERTIFIED  
PROFESSIONAL TOOLS  
**9000**  
DEVICES



SMALL PACKAGE. BIG FEATURES.

SALES, SUPPORT, / EMAIL: CONTACT@CONITEC.NET / WWW.CONITEC.NET. TEL: 619-462-0515. FAX: 619-462-0519

**PCB-POOL®**  
SERVICING YOUR COMPLETE PROTOTYPE NEEDS

**Price Example:** 16 Sq-Inches (double sided pth)

**2 Days: \$ 90.00**  
**8 Days: \$ 22.50**

Standard PCB-Pool Service  
SIMPLY SEND YOUR FILES AND ORDER ONLINE!

**New Service:** **WATCH "ur" PCB®**

Save vital time on design errors in advance of receiving your Prototype. View high resolution photographic images of your PCB during each production stage. Be one step ahead, use our realtime PCB monitoring service.

**WWW.PCB-POOL.COM**

**Target** **PROTEUS** **Protel** **Electronics WORKBENCH** **OrCAD** **Altium** **Easy-PC** **EDA** **GraphiCode** **R**

**DOWNLOAD OUR FREE PCB SOFTWARE**  
[www.free-pcb-software.com](http://www.free-pcb-software.com)

**LEAD FREE**  
NO ROHS COMPLIANT

**Tollfree USA: 1877 390 8541**  
[sales@beta-layout.com](mailto:sales@beta-layout.com)



# NEWS BYTES

Continued from Page 33

transmission — multiple 10 Gbps-plus signals traveling over multiple fibers or lanes, D'Ambrosia says. "There has been a lot of maturing in 10G technology" around bonding together multiple links, D'Ambrosia says. "Everyone [in the HSSG] has a high comfort level that we can leverage existing technology" to achieve a 100G standard.

A recent multi-vendor demonstration showed one possible implementation of this kind of parallel 100G Ethernet. The test involved a pre-standard 100G Ethernet protocol stack, which bonded together 10 10 Gbps links and transmitted them over separate optical wavelengths.

Compared to the current standard for link aggregation, the 100G demo was "similar, but different," says Serge Melle, vice president of technical marketing for Infinera.

"Link aggregation groups allow you to group multiple 10G channels together, but this has limitations on scaling," because a total of eight links can be bonded, Melle says. "What we demonstrated is truly a 100G at the [media access control] layer."

The demonstration was conducted using a Xilinx field-programmable gate array (a software-programmable chip), which acted as the physical 100G Ethernet MAC layer. Traffic from this layer was transmitted to Finisar short-reach optical transceivers, which split the signals into 10 different 10Gbps dense wavelength division multiplexing wavelengths, sent over Infinera DWDM gear. At the other end of the link, the 10 separate wavelengths were reassembled so that that transmission appeared as one logical data flow. Level 3's optical network was used in the demonstration, which transmitted 100 Gbps between Houston and Tampa, FL. Copyright 1995-2006 Network World, Inc. [www.networkworld.com](http://www.networkworld.com)

## MAKE YOUR EXISTING MOBILE COMPUTERS "TALK" TO YOU

**B**arcoding, Inc. ([www.barcoding.com/information/push-to-talk.shtml](http://www.barcoding.com/information/push-to-talk.shtml)), the nationally recognized leader in automated data-capture solutions, announces a new Voice-Over-IP (VoIP) technology for wireless mobile computers.

The technology allows multiple devices to communicate with each other over an 802.11 wireless RF network. This eliminates the need for employees to carry voice-communication-only devices, such as walkie-talkies or phones, because their existing data collection device can perform the voice communication functions.

The software currently works on products from Symbol Technologies and is Symbol +Plus Validated. Coming soon, Barcoding will be offering this solution on Intermec, PSC, Hand Held Products (HHP), and LXE handheld devices. The software is currently cross compatible with multiple operating systems, including Pocket PC® 2003, Windows CE 4.2®, Windows Mobile 5.0®, and Windows CE 5.0® devices.

Jay Steinmetz, CEO of Barcoding, Inc., says, "The ability for a user to have an unimpaired experience with voice and data on the same device makes this a truly unique application and a 'must have,' next-generation solution for enterprises deploying Windows Mobile RF/wireless terminal devices."

## PROTEUS

**The Complete Electronics Design System**



**EASY TO USE  
CAD TOOLS AT  
FANTASTIC PRICES!**

### Schematic and PCB Layout

- Powerful and flexible schematic capture.
- Auto-component placement.
- Rip-up and Retry PCB routing.
- Polygonal gridless ground planes.
- Library of over 8000 schematic and 1000 PCB foot prints.
- Bill of materials, DRC reports and more.

### Mixed Mode SPICE Circuit Simulation

- Berkeley SPICE3F5 simulator with custom extensions for true mixed mode and interactive simulation.
- Six virtual instruments and 14 graph based analysis types.
- 6,000 models including TTL, CMOS and PLD digital parts.
- Fully compatible with manufacturers' SPICE models.

### Proteus VSM - Co-simulation & debugging for popular Micro-Controllers

- Supports PIC16 & PIC12, AVR, 8051, HC11 and ARM micro-controllers.
- Latest version includes 40 new PIC18's.
- Co-simulate target firmware with your hardware design.
- Includes interactive peripheral models for LED and LCD displays, switches, keypads, virtual terminal and much, much more.
- Provides source level debugging for popular compilers and assemblers from HiTech PICC, Crownhill, IAR, Keil and others.

### PCB AutoRouting

- Proteus PCB design includes an interface to the Electra Gridless autorouter.

**FREE DOWNLOADABLE DEMO! Save Time. Save Money.**  
**Proteus Starter Kit - \$279 • Complete Systems from \$549**  
**"This is clearly superior in every respect."**

**R4** SYSTEMS INC. Tel: 905-898-0665  
[www.r4systems.com](http://www.r4systems.com) [info@r4systems.com](mailto:info@r4systems.com)

## PIC Programming Made Easy! Proton+ PICBASIC Development Suite



### Next Generation IDE

Proton IDE is a professional and powerful visual Integrated Development Environment (IDE) which has been designed specifically for the Proton Plus compiler. Proton IDE accelerates product development in a comfortable user environment without compromising performance, flexibility or control.

- Code Explorer
- Compiler Results
- Programmer Integration
- Integrated Bootloader
- Serial Communicator
- Online Updating
- Plugin Architecture
- Real Time Simulation Support

**FREE  
DOWNLOADABLE  
DEMO**

Visit [www.r4systems.com](http://www.r4systems.com) to see our latest **Proton+** projects

### SAVE TIME WITH END TO END INTEGRATIONS

**NEW IDE** - New IDE makes development using Proton+ even faster and more intuitive!  
**COMPILER** - The popular Proton+ compiler has enhanced support for I<sup>2</sup>C, SPI, Dallas 1-wire bus, RS232, X10, Compact Flash Memory Cards and USB.  
**VIRTUAL SIMULATION** - Simulate your project in RealTime using the integrate Proteus Virtual PIC Boards.



■ BY L. PAUL VERHAGE

# BALLOONSATS, PONGSATS, AND THE IDAHO CLUSTER BOMB

**THIS MONTH, I HAVE SEVERAL TOPICS to discuss. The nice thing about them all is that they can be expanded upon. So, expect to hear more about them in the coming months.**

## HOBO DATALOGGER CONVERTER

I've used three forms of data loggers in near space. The first two use the MAX186 and ADC0834 and are components in the flight computers I've designed. The third data logger

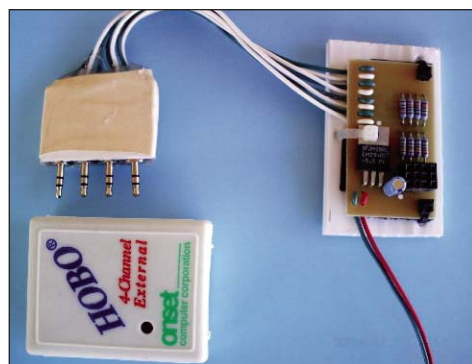
I've used is a Hobo (see Table 1).

When considered for their typical application, each data logger is very capable. For instance, the Hobo is outstanding for student BalloonSats. But it does have a limited voltage range (only 2.5 volts). There are many sensors that require five volts to operate and they produce an output voltage that can span five volts. How do you interface a five volt sensor to a 2.5 volt Hobo? The easy answer is to power the sensor with a five volt voltage regu-

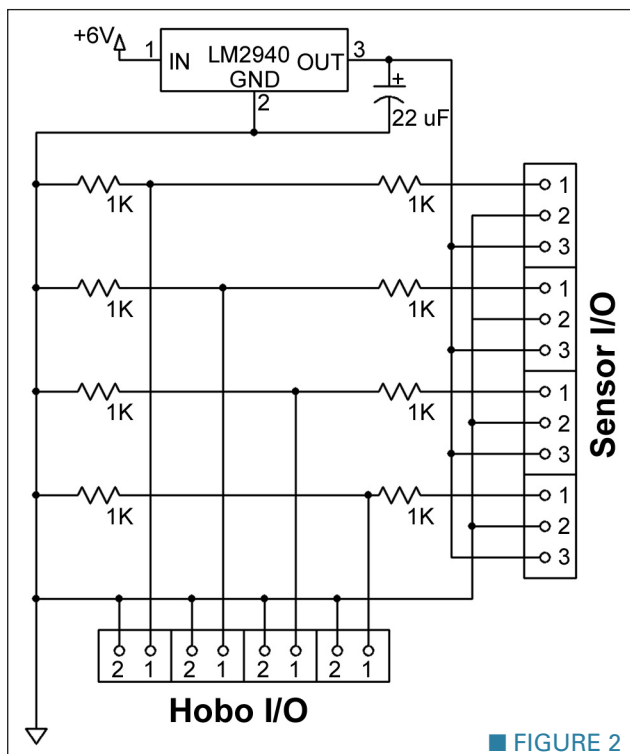
lator and send its output through a voltage divider. Figure 2 shows the Hobo datalogger converter I've designed to do just this (see Table 2).

Since I like to use the Hobo with four external channels, I designed the converter to be used with four sensors. The sensors plug into the input port of the converter and are powered with a low drop-out regulator, the LM2940T-5. I selected this regulator because it can operate with as little as 5.3 volts. The output voltage of each sensor is divided in half with a high precision voltage divider circuit. The sensor voltages are input to the Hobo with 3/32"

stereo jacks. The Hobo uses stereo jacks because it also provides power for the sensors plugged into it. The tip is the input voltage



■ FIGURE 1. Hobo Datalogger Controller.



■ FIGURE 2

| Logger Name | Voltage Range | Bits of Resolution | Voltage Resolution |
|-------------|---------------|--------------------|--------------------|
| MAX186      | 4.096         | 12                 | 1.0 mV             |
| ADC0834     | 5.0           | 8                  | 19.6 mV            |
| Hobo        | 2.5           | 8                  | 9.8 mV             |

■ TABLE 1

| Part                                     | Amount |
|--|--------|
| LM2940T-5 low drop-out voltage regulator | 1      |
| High precision resistors (1K or larger)  | 8      |
| 22 uF electrolytic capacitor             | 1      |
| Three pin receptacles                    | 4      |
| 3/32 inch (2.5 mm) stereo jacks          | 4      |

■ TABLE 2

to the Hobo and the base is the ground. So, solder the wires labeled 1, 2, 3, and 4 in the output to the tips of their respective stereo jacks. The wires labeled G are soldered to the base of the jacks. This leaves the ring, which is where the Hobo provides power for sensors that need it.

I discovered while making this circuit that the spacing between the Hobo input jacks is too narrow for the diameter of RadioShack's 2.5 mm stereo jacks and their housings. So, I used plastic and hot glue to make new housings for them. Begin by plugging all the jacks (that's jacks without their housing) into a Hobo. Cut two pieces of thin plastic (I like to use the thin Styrene sheeting sold at hobby shops) to cover the top and bottom of all the jacks. Give the jacks a good coating of hot glue (don't get glue on the Hobo) and stick one sheet of the plastic to the bottom of all the jacks. After the glue cools thoroughly, cover the top face of the jacks and cover that with the last piece of plastic. After the glue cools again, remove the jacks from the Hobo and fill any remaining holes in the housing with more hot glue. When that glue cools, trim the housing and cover it with heat shrink. The result is a unified housing for the jacks in your Hobo converter. Figure 1 at the beginning of this column shows what your housing should look like.

There are three large holes drilled into the PCB and they're marked as black circles in the parts placement diagram that's available on the *Nuts & Volts* website at [www.nutsvolts.com](http://www.nutsvolts.com). These are for bolts: two to mount the PCB to a backing like Correplast and the third to bolt the voltage regulator to the PCB. Or, they can be used to zip-tie the PCB to a sheet of Correplast as you can see in Figure 1. The gray colored holes in the placement diagram are strain relief for the power and output cables. Insulated wires pass through them before being soldered to the PCB. Their solder pads are the small black dots at the end of the lines.

The Hobo converter is a simple enough PCB that I'll shoot copies of the PCBs for *Nuts & Volts* readers who want one. Since I can drop it in an envelope with a 39 cent stamp, I'm

asking \$4 for each one to cover my expenses. This offer is good for as long as I'm not swamped with orders (not very likely, I suspect).

## PONGSATS: SMALL VOLUME, BIG POTENTIAL

Here's a challenge for you. Design a near space experiment to fit inside of a ping pong ball (see Figure 3). JP Aerospace invented this concept several years ago and calls it the PongSat. For more information on their PongSat program, go to the JP Aerospace website ([www.jp-aerospace.com](http://www.jp-aerospace.com)) and download their PongSat document. I've always felt their PongSat documentation was too brief, so after my NearSys 06C mission, I decided to experiment a bit with them. One reason I did this is because it's a long drive from Grand Island, Nebraska to home. And I had to find something to think about during my drive or I'd go crazy. So here's what I came up with. I'll leave it up to the reader to decide if mulling over PongSats worked or if I did indeed go crazy.

First, I wanted to find a good way to safely open a ping pong ball. I agree with JP Aerospace that trying to cut one open with an Exacto knife is too dangerous. But I also believe that using a coping saw is not much safer. My first attempt was to use a stationary sander. I was hoping the sander would smoothly sand a circular hole into the ping pong. Perhaps this will work with a new sanding belt, but in my test, belt friction merely created a soft spot in the ping pong ball. Next, I came up with using cuticle scissors — tiny scissors designed for very fine cutting. But scissors need a line to cut along if the cut is to be accurate. So, I first drew a 3/4 inch diameter circle on a ping pong ball by using a plastic circle template. With a small drill bit (or Exacto knife), I made a starting hole for the scissors in the ping pong ball. Then I was able to cut a nice

■ **FIGURE 4.** The tools I used to safely open a nice hatch opening in a ping pong ball.

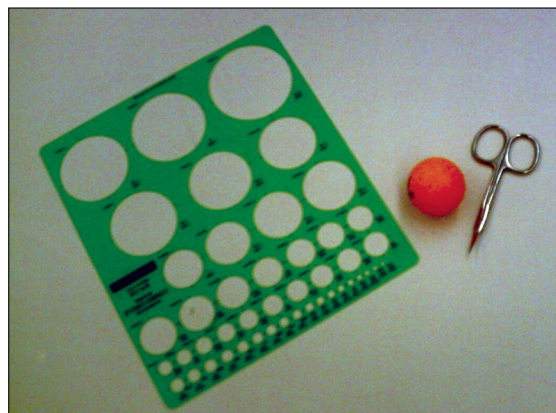


■ **FIGURE 3**

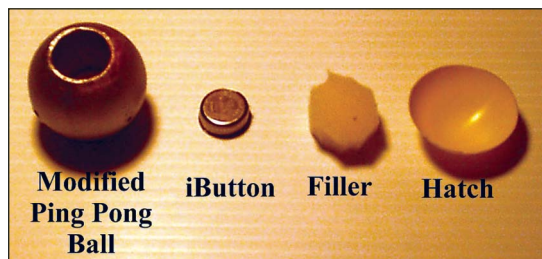
3/4 inch diameter opening in it.

To close the ping pong ball, I made a hatch from a second ping pong ball. I used the same plastic circle template to draw the hatch, but this time I drew a larger 1-3/8 inch diameter circle. This simple PongSat can be filled with an experiment and the hatch taped over the opening. I thought this would be a nice beginning, but unfortunately, it would let small experiments bounce around inside the ping pong ball.

To further restrain an experiment inside the PongSat airframe, I glued a tube into the ping pong ball. In this case, I used a 3/4 inch diameter cardboard rocket tube (this is why I cut the hole 3/4 inches in diameter in the first place). The rocket tube was cut 1-1/4 inches long and super-glued inside the opening in the ping pong ball (I've also used epoxy). The 3/4 inch diameter tube was used because it's large enough to hold a Thermochron. A Thermochron for my new readers is a stainless steel can the size of five dimes that contains an entire temperature logger. You can read about the







■ **FIGURE 5.** The exploded PongSat. It's pretty simple.

PongSat. The raceways stack each PongSat beneath the bottom of the near spacecraft. A folded piece of Dacron kite line works very well to suspend the PongSats (see the diagram in Figure 7). The ends of the

Thermochron and other iButtons at the Dallas-Maxim website ([www.maxim-ic.com](http://www.maxim-ic.com)). A Thermochron isn't 1-1/4 inches tall, so to restrain it inside the PongSat compartment, I cut two disks of foam rubber to fill the remaining space inside the PongSat and to cushion the Thermochron.

JP Aerospace loads PongSats into a hopper and launches the lot on a near spacecraft. I wanted to try something different, so next I designed a way to suspend each PongSat from the near spacecraft. This gives each PongSat full exposure to near space. I drilled two 3/16 inch diameter holes vertically through the ping pong ball. The holes are 3/4 inches apart and pass just outside the 3/4 inch diameter rocket tube inside the ping pong ball. Two pieces of 3/16 inch OD plastic tubing is glued through the holes to form two raceways through the

Dacron line are tied to the bottom of the last module of the near spacecraft after all the PongSats are added.

I finished each PongSat by painting them and their hatches with plastic model spray paint. With a coat of paint, the PongSats look more serious. The internal volume of my PongSat design is large enough that even with a Thermochron inside, there's enough room for stuff like seeds or an insect. The Thermochron inside the PongSat records how cold the samples inside the PongSat get during their flight. The diagram below should clear up any questions about my PongSat design.

My PongSats made their first near space mission in July '06. They were part of the University of Nebraska payload that I flew on NearSys 06D. The experiment involved painting one PongSat silver and the other one black and then looking for differences in their temperatures.

Upon recovering my first PongSats in a corn field, I discovered that the corn stalks snagged the PongSat hatches and yanked them open. I lost one Thermochron as a result. So, it was back to the drawing board for one

more change to my design. Instead of taping the hatch on, I now use a rubber band. To prevent the rubber band from slipping off the spherical ping pong ball, I drilled two holes in the back of the ball that are 1/2 inch apart. The two holes are placed so that they both fit inside the 3/4 inch tube. I passed the rubber band through both holes. So far, the rubber band has not slipped out of the holes, but I did tie two knots in it.

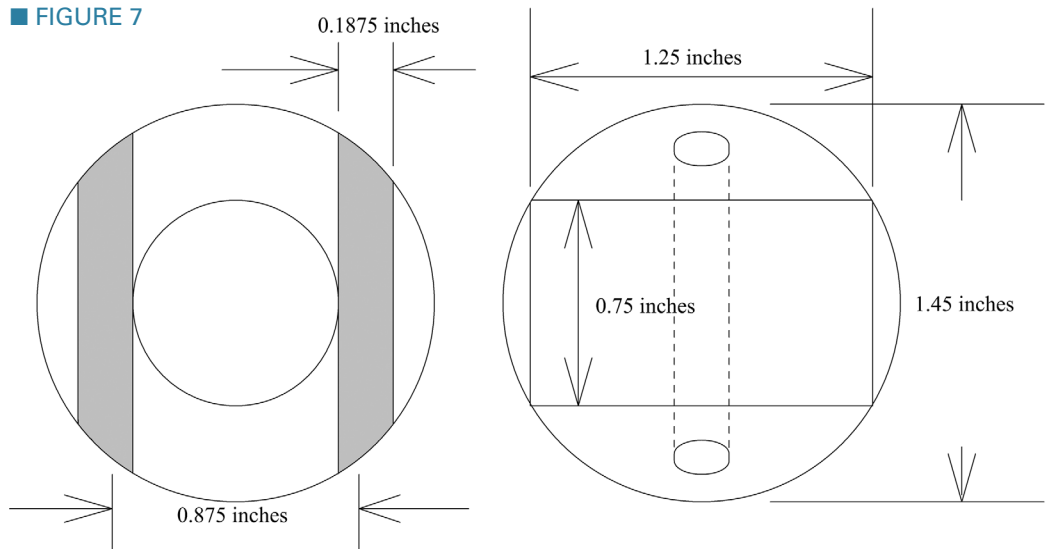
Now the hatch needs a modification for the rubber band to hold it against the PongSat airframe. I drilled a hole through the hatch's center and bolted a #4 nylon bolt through it. The hatch is sandwiched between two nuts on the bolt so that the bolt head stands above the top of the hatch. The hatch is held in place by wrapping the ends of the rubber band around the bolt head. I found that the nylon bolt is a nifty handle for the hatch. This design has worked well and I've flown it on several missions in 2006.

So far, I'm really happy with this design, but I have a second one to describe. I wanted to find a way to use a screw-on cap in place of a hatch. So, I stopped at a hobby shop to purchase plastic coin tubes. These are plastic tubes with screw-on caps that coin collectors use to store their coins. It turns out that the tube that dimes are stored in has a diameter of 3/4 inches. So, I trimmed a coin tube to a length of 1-1/4 inches long (measured from the end of the tube's threads) and glued it into an opened ping pong ball.

■ **FIGURE 6.** Three PongSats on a loop of kite string. The ends of the kite string (I use a Dacron kite line) are tied in a loop and the loops are attached to the bottom of a near spacecraft. During a mission, they dangle below the near spacecraft and are fully exposed to near space.



■ **FIGURE 7**



■ **FIGURE 8.** The color of a PongSat does affect its internal temperature, as you can see in this chart. Note that the Thermochrons have a minimum temperature of -40 degrees. That's why the temperature data bottoms out at -40.

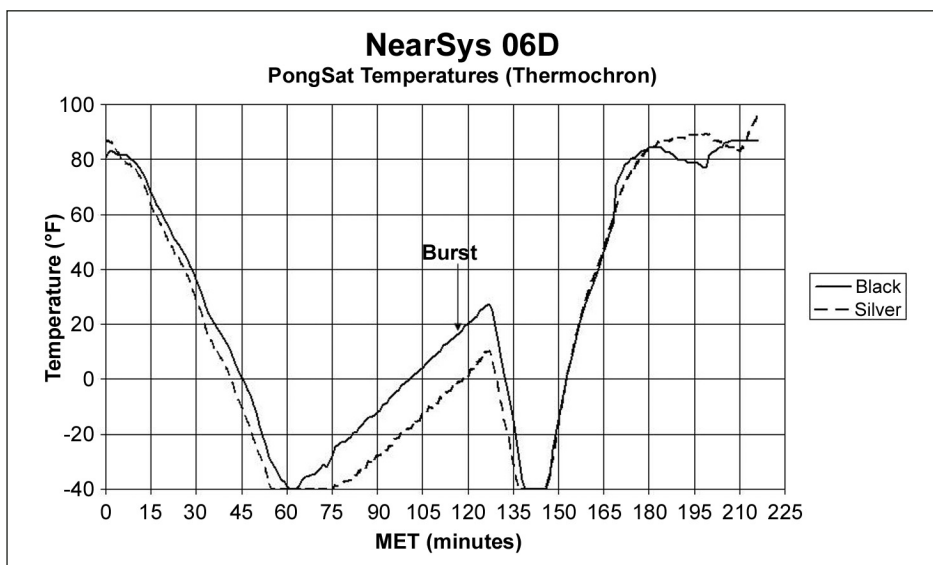
As with the previous PongSat design, I drilled holes for two vertical raceways though the ping pong ball and glued the plastic tubes in place. I have found this design to be an ideal PongSat for carrying plant seeds. Figure 10 is an example of one of my PongSats with a coin tube. (In the next Near Space column, I'll describe another variation to the PongSat and the PongSat Flight Computer I've designed.)

## THE IDAHO CLUSTER BOMB

I have a different kind of experiment that you can do in near space. No doubt many readers have noticed that bags of potato chips are sealed air tight to retain their freshness (with the additives they add to chips, I'm surprised this is necessary). So when you take a bag of chips on a trip to the mountains, you've probably noticed that the bag pressurizes as you climb higher. Have you ever wondered if it's possible for the air pressure to drop so low that the bag bursts open? Here's how I found the answer to that question.

First, you need to know that potato chip bags are made by wrapping a sheet of plastic into a tube and then sealing the top and bottom of the tube. That means there are three seams in each potato chip bag. At first glance, it would seem that any one of them could burst open with enough pressure. But if you squeeze a sealed bag of chips, it's one of the end seams that invariably fails, and not the side seam. This is good. For the most dramatic effect, we want to force the bottom seam to fail before the top seam. If the top seam bursts first, then the product inside the bag remains inside

■ **FIGURE 9.** A PongSat with its hatch closed and secured with a rubber band. Rubber bands can make several flights into near space before they degrade from the cold, ozone, and ultraviolet.



the bag. But if we can get the bottom seam to fail, gravity will empty the bag of its potato contents. And that is how the Idaho Cluster Bomb (ICB) works.

## MAKING THE ICB

For this experiment, you'll need to first purchase an inexpensive bag of potato chips (Figure 12).

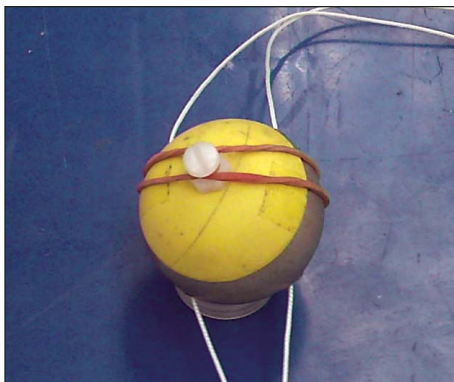
Then reinforce the top seam by folding duct tape over it. Cut a 3/16 inch diameter dowel a couple of inches longer than the width of the chip bag. Further reinforce the seam by rolling it around the dowel and tape together with more duct tape. You gotta love duct tape — it can do anything (Figure 13).

Tie two nylon cords to the ends of the dowel extending beyond the sides of the bag, as shown in Figure 14. Use the other ends of the nylon cords to tie the ICB to the bottom of a near spacecraft.

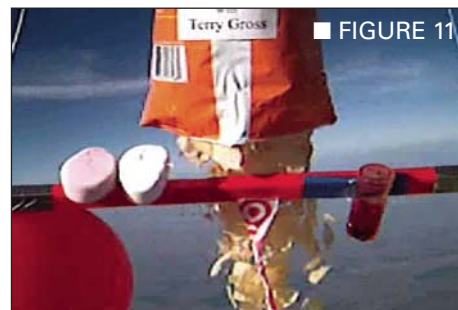
The dowel is used to keep the top

seam straight. This way, there's less stress on the bag because it doesn't sag under its own weight. Because of the dowel and duct tape, the weakest seam of the bag is now its bottom seam. In every flight that I have prepared a potato chip bag this way, it has returned from near space empty.

Having bags of chips return from near space empty is nice, but I wanted to know when and where they burst. I could get a good idea where the bags burst if I know what pressure is low enough to burst a bag. So, I looked around for a vacuum chamber. My plan was to pump down several bags and average their bursting pressure. I then quickly discovered



■ **FIGURE 10**



■ **FIGURE 11**





■ FIGURE 12



■ FIGURE 13

that no one wanted a greasy bag of chips inside their vacuum chambers.

So instead, I flew a prepared bag along with a digital camera. The digital camera recorded so many images that one of them captured evidence of the bag burst (see Figure 16).

Better yet, I also sent a digital video recorder with the bag of chips. In Figure 16, you'll notice that the bag of potato chips is attached to the right end of a boom. There are additional

experiments along with the potato chip bag, like balloons and marshmallows. On the left end of the boom and well hidden in Figure 16 is a Fidelity DV 5900 digital recorder. For two hours it recorded video of the chip bag, balloons, and marshmallows. It's obvious in the video that the bag is pressurizing. At an altitude of 15,000 feet, the bottom seam burst and the chips spilled out. Amazingly, when the seam burst, it burst completely, there was no



■ FIGURE 14. Notice that all the knots are wrapped in duct tape for additional security.

half way. It took a couple of seconds for the chips to fall out of the bag. Air pressure inside the bag didn't push the chips out; it was all gravity's work. You can watch the video I made of the chip bag burst on [www.youtube.com](http://www.youtube.com). The video is called NearSys 06E and can be found by searching under the terms, NEAR SPACE.

## TWO ADDITIONAL EXPERIMENTS

A part of mission NearSys 06G

## DIGITAL CAMERA COMMENTS

Let me make two comments on digital cameras, both based on my experiences. First, don't use cameras that can only record images within built-in memory or cameras that require constant battery power to retain images. Instead, use a digital camera that uses SD cards. These cameras retain their images even when the battery fails. Also, you can

remove the memory card and download the images directly to a PC or laptop. That way, there are no camera-specific drivers to install. In addition, SD cards let you expand the number of images you can record during a mission simply by replacing your current card with a larger card. When it comes to near space, it's better to have lots of

boring images to sort through than to have too few images that may have missed something interesting.

My second comment concerns the combination digital video camera, still camera, and audio recorder. Not only do these devices record, they also play back. The only problem with this type of camera is that its selector switch is a rotary switch. So, it's possible to accidentally switch it from record video to play back when you insert the camera into a near spacecraft.

I can testify that it's really rotten to discover that your camera tried to play back a recorded file for two hours instead of recording new video from near space. Here's where electrician's tape comes in handy. Tape the selector switch to its proper setting before loading it into the near spacecraft. Now, it's almost impossible to accidentally switch it to play back and miss that great video after recovery.

■ This video recorder is a fidelity DV 5900 camera. I get over two hours of video with a 1 GB SD card.

### Selector Wheel







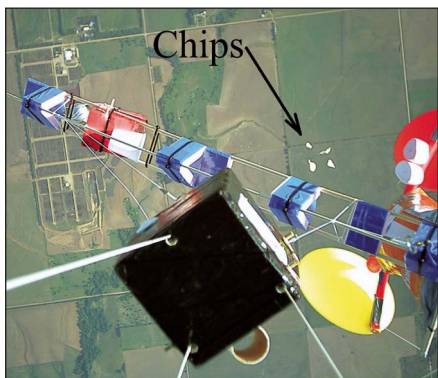
■ FIGURE 15. The camera has recorded an image of the bag during descent, just after the balloon has burst.

was a zip lock bag. Inside the bag, Gene Harlan (the publisher of *Amateur Television Quarterly*, [www.hampubs.com](http://www.hampubs.com)) placed a one dollar bill. The hope was that the bag's seam would burst open, spilling the dollar bill. But at recovery, we discovered the zip lock bag remained sealed. Apparently, a zip lock bag can retain internal pressure better than a potato chip bag. That means they can be used to safely send insects into near space. So think of a zip lock bag as an inexpensive space suit. One precaution is in order here. We didn't inflate the bag fully before sealing it shut. So a zip lock bag may be able to fail, depending on how much air it's filled with before launch. Gosh, if that doesn't sound like another near space experiments!

Lastly, in 2007 I want to launch a bag of marshmallows. If the bag will burst open, the marshmallows may explosively expand at burst and then fall to Earth. Won't that make a great video?

Until next time,  
Onwards and Upwards **NV**

■ FIGURE 16. Look out farm! Here comes potato chips from Idaho.



# Save 5% when you mention this ad★

Huge Inventory. Secure Online Shopping. Same Day Shipping★★

## Save up to 60% off Retail Prices!



### The "Backbone" Sony CCD Camera

The easiest security camera to work with. The backbone of any security system!

-----  
List Price: \$149.99

Yours from: **\$95.00**



### Amazing Deals on Infrared!

Professional domes and bullets available up to 120ft range!

-----  
List Price: \$119.99

Yours from: **\$85.00**



### Exclusive Composite to VGA Converter!

The simplest and least expensive solution for VGA!

-----  
List Price: \$99.99

Yours from: **\$69.00**



### CAT5 Video Amplifiers

Video over 1500ft using inexpensive CAT5 instead of Coaxial!

-----  
List Price: \$39.99

Yours from: **\$21.00**



### True CCD Mini Dome Cameras

Low Priced, professional quality cameras in 2-3 inch mini domes!

-----  
List Price: \$89.99

Yours from: **\$49.00**



### Powerful Wireless A/V Transmission

Multiple frequencies up to 3000ft distance. Simple RCA connection!

-----  
List Price: \$99.99

Yours from: **\$59.00**



"Price, Product and Service you can Trust!"

★ use promo code NVPRMO at checkout    ★★ on most items

Q5USA.com assumes no responsibility for typographical error, omission or other erroneous data construed herein.

Many Other Models Available at

# WWW.Q5USA.COM

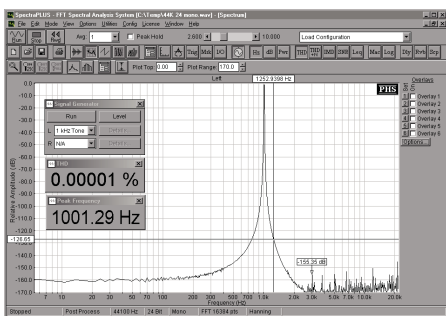
## 1-866-514-4111



## Turn Your PC into a Real-Time Audio Spectrum Analyzer

### Features

FFT to 1048576 pts  
24 bit, 192kHz  
1/96 Octave  
Dual Channel  
3-D Surface Plot  
Spectrogram Plot  
Digital Filtering  
Signal Generation  
RT-60, Leq, Delay  
THD, IMD, SNR  
DDE, Logging  
Vibration Analysis



## SpectraPLUS 5.0

*FFT Spectral Analysis System*

**Download 30 day FREE trial!**

**[www.spectraplus.com](http://www.spectraplus.com)**

**Starting at \$295**

**PHS**

Pioneer Hill Software  
24460 Mason Rd  
Poulsbo WA 98370

360 697-3472 voice  
360 697-7717 fax  
[pioneer@telebyte.com](mailto:pioneer@telebyte.com)

## Seetron Serial LCDs

Interface a sharp LCD display to your BASIC Stamp® or other micro-controller project with ease. No-solder wiring harnesses and easy mounting kits available too. See [www.seetron.com](http://www.seetron.com) today.

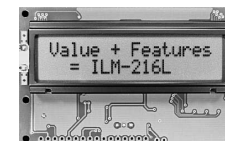
- 3.2 x 1.4 in. supertwist LCD
- 2400/9600 baud serial
- Low ( $\approx 2\text{mA}$ ) current draw
- Great with BASIC Stamps®

**\$45**  
BPI-216N



- 3.2 x 2 in. backlit LCD
- 1200-9600 baud serial
- Advanced protocol, 4 switch inputs
- EEPROM for configuration settings
- Favorite for OEM applications

**\$49**  
ILM-216L



- 3.2 x 1.4 in. graphics LCD
- 2400/9600 baud serial
- Font and 15 screens in EEPROM
- Easily draw points, lines, screens

**\$99**  
SGX-120L



- 3 x 2 in. supertwist LCD
- 1200-9600 baud serial
- ESD-protected, 4x4 keypad input
- Store up to 95 screens in EEPROM

**\$119**  
TRM-425L



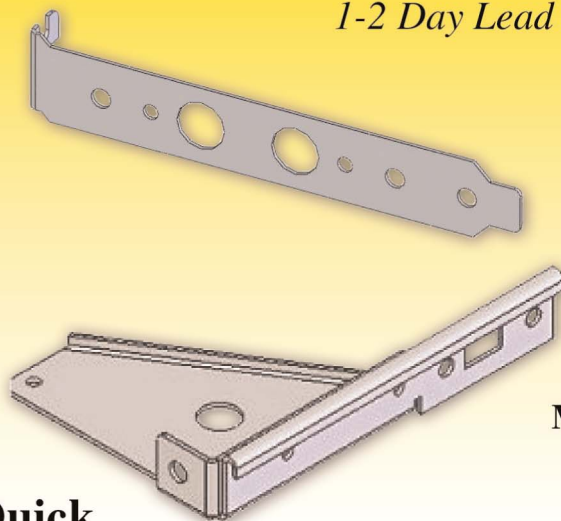
**Scott Edwards Electronics, Inc.**

1939 S. Frontage Rd. #F, Sierra Vista, AZ 85635  
phone 520-459-4802 • fax 520-459-0623  
[www.seetron.com](http://www.seetron.com) • [sales@seetron.com](mailto:sales@seetron.com)

More displays available,  
including bright VFDs.  
See [www.seetron.com](http://www.seetron.com)

## Metal Fabrication

*1-2 Day Lead Times Available*



**Both of these parts were  
ordered on Wednesday  
and shipped FedEx on  
Thursday.**

**Materials from 0.001" to 6.000" in thickness.  
Parts from practically any material.**

- ★ Quick
- ★ Affordable
- ★ Precise
- ★ No Minimums



**Complete Fabrication Center**  
Integrated Ideas & Technologies, Inc.

*Precision Laser, Waterjet, Plasma, Machining,  
Forming, and Welding Capabilities*

3896 N. Schreiber Way • Coeur d'Alene, ID • 83815-8362 • USA  
Ph (208) 665-2166 • Fax (208) 665-5906 • [www.iitmetalfab.com](http://www.iitmetalfab.com)



**We search the world for time-saving,  
easy-to-use state-of-the-art products!**

**Testing**

**PenScope**



**PP315** - High-perf. USB2.0-pwr'd scope-in-a-probe! Up to 100MS/s, 25MHz 24kS buffer. +/-100mV to +/-20V. 20ns/div - 50s/div C/VB/Delphi/LabView/VEE drivers. **\$199**

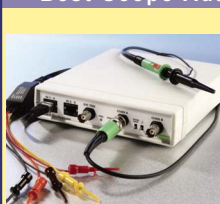
**NEW**

**Handheld Scope**



**HDS1022M** - 20MHz 2-ch standalone scope with USB connection and 3.8" color LCD. Built-in meter - great for your tool kit. **HDS1022M \$599**

**Best Scope Adapter Anywhere!**



100 MHz Scope and Logic Analyzer lets you do complex triggering to find hard-to-get-at glitches, spikes, etc. Huge 4 MB buffer for deep data drilling and zooming. Optional built-in swept signal generator. 2 x 10 bit Analog channels with more than 60 dB dynamic range. 8 digital input lines for mixed signal display and triggering.

**CS328 \$999**  
**CS700 (signal generator) \$199**

**EMI Tents**



EMI shielding tents made from Ni/Ag fabric. -86dB 20MHz to 18GHz. Portable - tabletop to room/lab size for on-site, on-demand pre-compliance testing. External PVC or aluminum frame. **from \$3500**

**NEW Low-Cost! LCD Scope**



**PDS5022** - 25MHz 2-ch + trig. Standalone bench scope with USB connection and 7.8" color LCD. Built-in meter - great for your service kit. **PDS5022S \$399**

**I2C**

**USB to I2C**



**USB I2C/I/O** - Provides a simple "drop-in" solution for connecting your PC to 90kHz I2C + 20 I/O lines. Free software. Use multiple boards for more I2C/I/O. **USB I2C/I/O \$79**

**Ethernet to I2C**



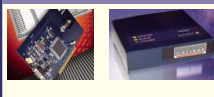
**NM7101A-LF** - Complete, hardwired TCP/IP-I2C module. Offloads stack for hi-speed Internet-enabling microprocessor systems. Drop-in W3100A-based board for instant network speeds to 8Mbps. **\$21.99**

**Ethernet to I2C**



**FMod-TCP** - TCP/IP server with I2C, 19 x digital I/O, 5 x 10-bit A/D inputs, and UART serial interface. Connect I2C devices/sensors to an Ethernet network! **FMod-TCP from \$232**

**I2C for PCs**



**PC193LV**: industry-standard I2C card for PCs. **WINI2C/PCI** software gives windows-interface to develop and debug I2C bus systems. **UCA93LV** is new USB version. **NOW!** - transparently monitor at 400kHz! **\$499**

**I2C Monitor**



**I2C Bus Monitor** - AvitProf monitors bus traffic on I2C or SMBus to 400kHz. Master/slave/multimaster. Trigger output/filter for scope. **AvitProf \$499**

**FREE COFFEE**



**Call 1-888-7SAELIG**

**Mention Offer# SBW**  
to get a free Starbucks Card with your order!

While supplies last - not available with any other offers

**I/O**

**Stepper Motor**



**Easy-Step 3000** - Advanced stepper motor drive and control system for unipolar stepper motors up to 35V/3A - ideal for robots/industrial control - turns you into an instant motor control expert! **\$119**

**Signal Wizard**



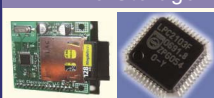
**Signal Wizard** - easy-use real-time DSP-based filter board for audio bandwidth signals. Design filters in seconds without any DSP knowledge! **Signal Wizard II \$399**

**FPGA systems**



**Hunt Eng** - RTG005 a new, self-contained ready-to-go FPGA system with CameraLink connection. Makes an ideal starter kit for developing image processing systems. **RTG005 from \$2995**

**FATfile Storage**



**Micro ALFAT-SD** - Ready-made way to easily add SD storage to your product. Serial data in - FATfile data out. - **\$39.95** Or design-in a micro ALFAT IC for MB storage - **\$14.00 ea.**

**Easy LCD**



**microLCD** - Easy way to add 2" sq LCD to your project. **microLCD 128 x 128 color LCD**. Add text/graphics/animations for any micro with serial or USB. **microLCD \$69**

**Touch-Sensing ICs**



**Quantum ICs** - World-beating capacitive sensor ICs for switching & control. Patented Adj. Key Suppression. Spread-spectrum, adj. sensitivity. In use worldwide by the world's largest consumer appliance manufacturers. **<\$1 (10K)**

**Ethernet**

**Serial-Ethernet Cable**



28" cable links serial devices to network without a PC, gives your product an instant IP address. 115Kbaud RS-232 port compatible with most 10/100Mbps Ethernet hubs. Network your serial product easily! **eCOV-110-P \$99.00**

**Ethernet to Serial**



**EG-SR-7150MJ** - Ready-to-go serial-to-Ethernet Gateway. Simple set-up for 10/100Mbps Ethernet - 230kbps serial. Ethernet/Internet-enable any serial port. **EG-SR-7150MJ <\$35**

**Ether-IO**



**Ether-IO** - UDP/IP-controlled 24 X digital I/O board. 3 x 8-bit TTL ports each independently programmable. Connects to any TCP/IP Ethernet network. **Ether-IO 24 from \$99**

**Ethernet to I2C**



**FMod-TCP** - TCP/IP server with I2C, 19 x digital I/O, 5 x 10-bit A/D inputs, and UART serial interface. Connect I2C devices/sensors to an Ethernet network! **FMod-TCP from \$232**

**TCP/IP IC**



**W3150A+** - Hardwired TCP/IP stack - cheap micros can now have internet capabilities at full speed! 10/100 Off-loads TCP/IP burden for fast time-to-market. Ethernet-enable almost ANYTHING! **<\$7.20**

**Motion Control**



**PIC-Servo** - Motion control boards with integrated power amplifiers for DC-servo/brushless-servo/stepper-motors. Easy connection to std serial ports for powerful multi-axis, mixed-motor control. **\$160**

**Wireless**

**Bluetooth**



**Emxys PearlBlue** - 100m-Bluetooth module (UART master/slave bridge). Easy connection for micro's to PCs, PDAs, phones, etc. **Emxys PearlBlue - PIC16F877** based emb. dev. system for short/long Bluetooth development. **<\$119**

**Radio Data**



**CDP-RX-02 (434MHz)** - UHF Narrow Band Radio Data Receiver and Transmitter Modules. Great for adding wireless capability to your equipment. **CDP-RX-02 \$144**

**easyRADIO**



**easyRADIO™** Transceiver Modules make wireless data transmission simple for USA and Europe! Add wireless capability to your project today! **ER900TRS from \$35 (100)**

**Wireless Controllers**



**Owasys** - GSM/GPRS/GPS/Bluetooth/Ethernet wireless controllers for M2M - for autos, machines, etc. **RS232/485/CAN/A/D-I/O. Owasys from \$479**

**TinyOne Zigbee**



**TinyOne Zigbee** - Complete RF solution for fast and reliable data transmission. Miniaturized OEM RF module ensures fast and easy integration into wireless applications. **TinyOne Zigbee <\$30**

**Data Modem**



**Data Modem** - USB-powered radio transceiver boards add wireless RS232 to your device! Get remote control for your product from PC USB port! **RTM-USA \$89**

**USB**

**Fast USB I/O**



**Byteparadigm** - Fast USB 2.0 multichannel input or output/ arbitrary digital waveform generator/ logic analyzer. 100MB/s burst; thruput to 48MB/s, 22 x I/O. **GP-22050-BASE \$1187**

**Easy USB**



**microUSB** - Tiny ready-made USB Interface to 1 Mbps 0.7" x 0.5" based on SiLabs CP2101. Gnd/RX/TX Suspend, Reset, & 3.3V 100mA source -40°C +85°C. **microUSB \$25**

**USB-Serial Adapter**



**USB-COM-S** - Serial port for laptops without one! Instantly adapts older RS232 products to USB! PC thinks it's using COMport but uses the USB - 45". **\$24.95 (1) or \$18.50 (100)**

**USB Bus Analyzers**



**Ellisis Tracker110/ Explorer200** high-performance, economical USB 1.1/2.0 protocol analyzers. **\$999/\$2999**  
**USBEX300** for debugging USB wireless Wimedia **CALL**

**GPS Logger**



**TrackStick** - Lipstick-sized logger tracks position data for shipments, vehicles, personnel, etc. Records date, time, location, speed, heading and altitude at pre-set intervals - shows route/speed on PC! **\$249**

**STOP THE PRESS!**  
- new products arriving every day!  
  
Please go to [www.saelig.com](http://www.saelig.com) for late-breaking announcements.

**www.saelig.com**

1-888-772-3544

**1-888-7SAELIG**



**info@saelig.com**

**585-385-1768 fax**



■ BY PETER BEST

## CORE NETWORKING DEVELOPMENT: ZIGBEE

**WHEN RABBIT SEMICONDUCTOR RELEASES a development kit, you can be sure that the electronics within that development kit are aimed at helping you learn about the latest and most popular technology. If you really want to understand how something works, purchase an associated Rabbit Development kit. For instance, I learned about 802.11b by absorbing the contents of their 802.11b development kit.**

**M**y reasons for feeling this way about Rabbit Semiconductor development kits revolve around the way that the Rabbit code and libraries are structured. Rabbit libraries are not compiled object files; Rabbit libraries are actual source code files that you can open with an editor, read, and study. Another Rabbit plus in my book is that every Rabbit development kit I've ever come into contact with works as designed with no compromises. The hardware is well designed and easy to use.

The idea behind all of Rabbit Semiconductor's development kits is to transfer enough knowledge about the subject, the firmware, and the Rabbit

Semiconductor microprocessor controlling the development board to allow the user (that's you) to build a similar application based on the development kit resources. In this edition of Design Cycle, we're going to take a tour of the new Rabbit ZigBee/802.15.4 Application Kit. Not only will you be introduced to the newest of the Rabbit Semiconductor development kits, you'll also gain some knowledge about MaxStream's XBee IEEE 802.15.4-compliant/ZigBee-ready transceivers. Before we examine the Rabbit stuff, let's take a look at what makes up an XBee.

### MAXSTREAM'S XBEE

ZigBee's intended mission is to cut the traditional wires between sensors, traditional wired slave devices, and the microcontrollers and microprocessors they serve. Thus, if ZigBee is to emulate a wire, what goes in must come out

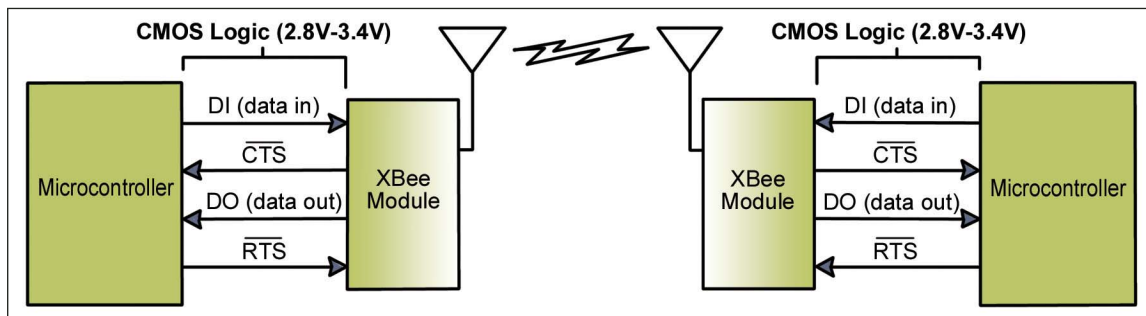
without any significant change. The MaxStream XBee ZigBee modules employ a UART interface, which allows any microcontroller or microprocessor to immediately use the services of the ZigBee protocol by way of the XBee's internal IEEE 802.15.4/ZigBee engine. All the ZigBee hardware designer has to do in this case is make sure that the host's serial port logic levels are compatible with the XBee's 2.8-3.4V logic levels.

The logic level conversion can be performed using either a standard RS-232 IC or with logic level translators such as the 74LVTH125 or 74HC125 when the host is directly connected to the XBee UART. Note that I didn't require the host microcontroller to have an on-chip UART. That's because it is a simple thing to emulate a basic UART with firmware. In fact, the Custom Computer Services C compiler has built-in UART emulation facilities aimed at Microchip's PIC microcontrollers. A

conception of a typical XBee communications link is illustrated in Figure 1.

Data is presented to the XBee module through its DIN pin and must be in the asynchronous serial format,

■ **FIGURE 1.** A simple three-wire serial interface is all you need to tie a microcontroller to an XBee ZigBee transceiver. The handshaking lines can be omitted if you follow ZigBee rules and send small packets at low cyclic rates.



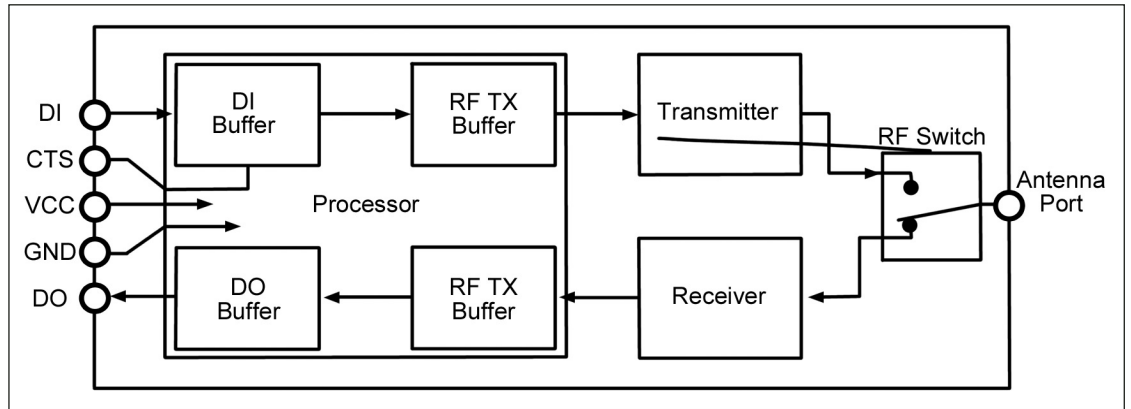
which consists of a start bit, eight data bits, and a stop bit. The XBee modules require the incoming serial signal to idle at a logic high state. Since the input data is going directly into the input of a UART within the XBee module, no RS-232 bit inversions are necessary within the asynchronous serial data stream. All of the required timing and parity checking is automatically taken care of by the XBee's UART, as well.

As you would expect, the XBee module produces a received data asynchronous serial data stream for the host on its DOUT pin. So, all you need is a simple three-wire (DIN, DOUT, Ground) serial connection to put ZigBee to work with the XBee module. Just in case you are producing data faster than the XBee can process and transmit it, the XBee module incorporates a CTS (Clear To Send) function to throttle the data being presented to the XBee module's DIN pin. You can eliminate the need for the CTS signal by sending small data packets at slower baud rates. If you're using the XBee modules in a true ZigBee fashion, the slower speeds and small frames will be automatic.

A simplified view of the XBee internals is represented in Figure 2. Incoming data flowing through the XBee module's DIN pin is buffered by the DIN Buffer until it can be transmitted. You have the option to send characters as they enter the DIN pin or buffer up a number of characters to send as a packet. When the XBee module is not sending characters, it can rest in idle mode, enter receive mode, process a command, or just sleep.

The default mode of operation is called Transparent Mode. In Transparent Mode, the XBee modules simply act as a serial line replacement. All data passing through the DI pin from the microcontroller's UART is queued up for RF transmission and all incoming RF data is routed out of the XBee's DO pin to the host microcontroller's UART input.

The XBee is the low-power version



of the MaxStream IEEE 802.15.4/ZigBee radios. The XBee-Pro effectively radiates 100 mW of RF power versus the XBee's 1 mW. Although XBee-Pro radios have the same mounting footprint and behave identically to their little brothers, XBee-Pro modules are not included with the Rabbit ZigBee/802.15.4 Application Kit, which we're about to take a look at.

## THE RABBIT ZIGBEE/802.15.4 APPLICATION KIT

The XBee RF Module interface board that is included in the Rabbit ZigBee/802.15.4 Application Kit is shown in Photo 1. The Rabbit ZigBee/802.15.4 Application Kit XBee RF Module interface board is very simple in design as it is only intended to provide easy access to the XBee module's serial interface and power. A voltage regulator resides underneath the XBee module with nothing mounted on the back side of the XBee RF Module interface board. There's just enough on the XBee RF Module interface board to allow the XBee programmer access to the XBee's serial interface and power connections.

The serial connector to the far left is connected directly to the XBee serial I/O pins while the RS-232 connector at the bottom of the XBee RF Module interface board is buffered by the RS-

**■ FIGURE 2.** The code in Listing 1 is written around the capabilities of the PCDR. If you're Rabbit challenged, you can download the complete Rabbit microcontroller system reference poster from the Rabbit website.

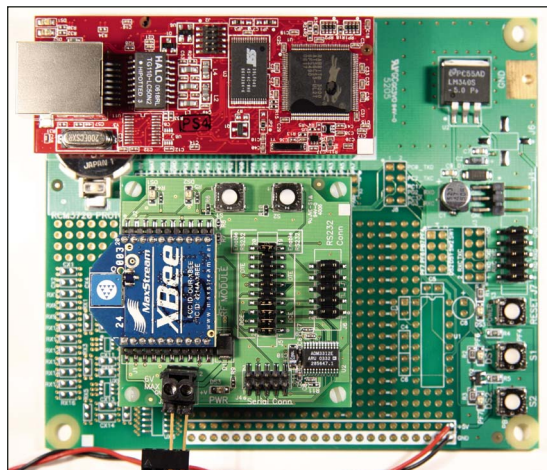
232 converter IC to its left. As I alluded to earlier, the Rabbit ZigBee/802.15.4 Application Kit XBee RF Module interface board can accommodate the XBee-Pro radio module, as well.

Naturally, the host microprocessor is a Rabbit. Photo 2 shows a RabbitCore RCM3720 microprocessor module mounted on a RabbitCore RCM3720 Prototyping Board. The Rabbit ZigBee/802.15.4 Application Kit XBee RF Module interface board in the shot — which is not physically mounted to the RabbitCore RCM3720 Prototyping Board — is included for clarity. The Rabbit ZigBee/802.15.4 Application Kit XBee RF Module interface board connects to the RabbitCore RCM3720 via the RS-232 connector at the far right of the RabbitCore RCM3720 Prototyping Board. As you

**■ PHOTO 1.** The only thing you don't see in this shot is the XBee's voltage regulator, which is nestled under the XBee module. Otherwise, there's an RS-232 converter IC, the basic interconnects, and some user switches and LEDs.







■ **PHOTO 2.** The RabbitCore RCM3720 is primarily used in Ethernet applications. However, since the XBee is a serial device and the RabbitCore RCM3720 module contains four serial ports, the RabbitCore RCM3720 can be used to spawn some really interesting XBee applications.

RCM3720 Prototyping Board, the RabbitCore RCM3720 module is really designed to have its .1-inch 2x20 dual-row IDC header plugged into a user-designed production motherboard.

can see in Photo 2, power for the XBee interface module is stolen from the RabbitCore RCM3720 Prototyping Board power rail.

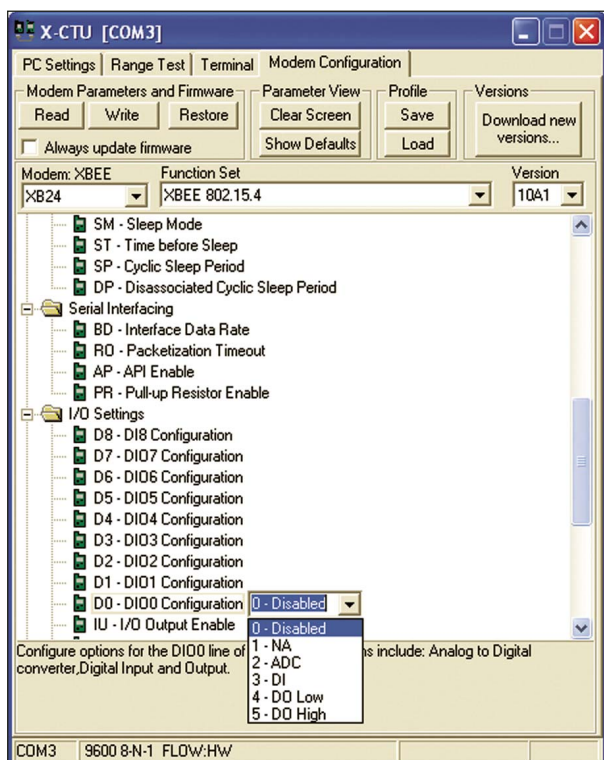
The RabbitCore RCM3720 module consists of a Rabbit 3000-based microprocessor with 512K of Flash and 512K of SRAM. The RabbitCore RCM3720 module also includes a fully functional 10 Mbps Ethernet interface, which is based on the omnipresent RTL8019AS Ethernet engine IC. The RabbitCore RCM3720 module offers 33 general-purpose I/O lines and four serial ports. Although we have the luxury of mounting our RabbitCore RCM3720 module on a RabbitCore

I won't post the schematics in print here, as you can get them easily from the Rabbit Semiconductor website ([www.rabbitsemiconductor.com](http://www.rabbitsemiconductor.com)). You'll find the complete set of schematic diagrams for the Rabbit ZigBee/802.15.4 Application Kit in the Product Documentation area of the Rabbit website. Just follow the Rabbit ZigBee/802.15.4 Application Kit link.

The XBee RF Module interface board in Photo 2 connects to the RabbitCore RCM3720 module's serial port by way of a standard ribbon cable. Rabbit firmware is written using Rabbit Semiconductor's Dynamic C 9.25 compiler, which also integrates

the Rabbit microprocessor's debugging environment. The XBee application firmware that runs on the Rabbit microprocessor is based on the XBee AT command set. The Rabbit ZigBee/802.15.4 Application Kit includes libraries that have taken all of the XBee AT commands and assembled them into simple C function calls. The parameters of the XBee AT command set are entered as function call arguments in the Dynamic C source code. Effectively, the XBee AT

■ **PHOTO 3.** Just about anything you want to do to an XBee or XBee-Pro can be done from this window. I've opened up the DIO variables so you can match them up to the text.



command set has been converted to function calls that return values solicited by the AT commands. Let's wander through a simple Rabbit ZigBee/802.15.4 Application Kit Dynamic C-based XBee application and see if we can figure out what's going on behind the scenes.

## XBEE FIRMWARE

The first order of business is to use X-CTU to configure the XBee module I/O to match the XBee RF Module interface board hardware. X-CTU is a personal computer application that is really part of the MaxStream XBee package. The X-CTU application is used to configure and test the XBee modules via a personal computer's COM port. X-CTU also incorporates a built-in terminal emulator function. You can download X-CTU from the MaxStream website ([www.maxstream.net](http://www.maxstream.net)).

Download the XBee RF Module interface board schematic and you'll see that the Rabbit ZigBee/802.15.4 Application Kit XBee RF Module interface boards are physically configured as follows:

- DIO0 = Output DS1 LED
- DIO1 = Output DS2 LED
- DIO2 = Input S1 pushbutton switch
- DIO3 = ADC BAT battery voltage monitor
- DIO4 = Input S2 pushbutton switch

Thus, we can use X-CTU to set up the XBee module's I/O pins this way:

- D0 - DIO0 Configuration = 4 (output low)
- D1 - DIO1 Configuration = 4 (output low)
- D2 - DIO2 Configuration = 3 (input)
- D3 - DIO3 Configuration = 2 (ADC)
- D4 - DIO4 Configuration = 3 (input)

I've found that pictures do indeed speak louder than words. So, rather than ramble along trying to explain the numbers behind the DIOX Configurations I just showed to you, I captured an example X-CTU session, which you can see in Photo 3.

Only the XBee End Device gets the general-purpose I/O configuration

treatment via the X-CTU. The XBee Coordinator is set up using X-CTU to allow devices to join the PAN and the XBee End Device is configured via X-CTU to automatically join the PAN. To make sure things were not out of my control, the PAN ID is preset to 0xAAAA in both the PAN Coordinator and End Device. I also shut down every channel except channel 11 by setting the SC (Scan Channels) parameter to 0x0001.

For those of you that got lost in that last paragraph, a ZigBee End Device is the least intelligent tool in the shed. A ZigBee End Device will normally sleep most of the time and only wake up to report the status of whatever it may be monitoring. For example, a typical ZigBee End Device may monitor such things as temperature, switch closures, or liquid levels. The ZigBee Coordinator is the boss of a PAN (Personal Area Network) as at power-up it seeks out a suitable ZigBee channel and creates a unique PAN around itself.

The ZigBee Coordinator is the sharpest tool in the shed and in most instances will rarely sleep as it has to keep watch over the ZigBee End Devices. The ZigBee Coordinator must listen continually for incoming data packets from End Devices. It is also the ZigBee Coordinator's job to allow or disallow requesting ZigBee End Devices to join its PAN.

Thus, we used X-CTU to configure the general-purpose I/O of a ZigBee End Device that is monitoring two logic level inputs (switch inputs) and an analog-to-digital converter (battery monitor) input. The ZigBee End Device we configured also has control of two logic level outputs, which are attached to a pair

of LEDs. The ZigBee Coordinator can possibly have access and control to all of the ZigBee End Device's resources.

One of the unique non-IEEE 802.15.4/ZigBee things that can be configured on an XBee module is a Node ID. In the XBee world, a Node ID (NI) is an ASCII name that is associated with the ZigBee node. In our little peer-to-peer network, the PAN Coordinator has an NI of DIO-COORD and I assigned an NI of STARCHILD-1 to the End Device.

I'll use Dynamic C's STDIO window to show you the results of the execution of the XBee library function calls. The application we will be examining uses the RabbitCore RCM3720's D serial port. If you've never programmed in Dynamic C, you've probably never closely examined the layout of the Rabbit microprocessors' general-purpose I/O logic. Figure 3 is a graphical depiction of the RabbitCore RCM3720 module's Port C, which is synonymous with PCDR in Listing 1. You can get a full picture of the Rabbit 3000 microprocessor layout by downloading the Rabbit 3000 Easy Reference

Poster from the Rabbit website. The poster file can be found by following the Rabbit 3000 microprocessor link on the Product Documentation page.

The next step in the firmware chain involves setting the initial baud rate of the Rabbit microprocessor's serial port, enabling the serial port flow control (RTS/CTS), and flushing the RabbitCore RCM3720 module's serial port buffers. That's all done in Part 2 of Listing 1. The `brdInit` function has been present in every other Rabbit development kit I've had experience with. The initial operational states of the Rabbit microprocessors general-purpose I/O are established within the `brdInit` function's code. As you can see, the Rabbit Dynamic C source code is self explanatory.

The next piece of code listed in Part 3 of Listing 1 uses one of the XBee library functions, `xb_atModeOn`, in an attempt to contact the XBee PAN Coordinator module, which is serially attached to the RabbitCore RCM3720 module via a ribbon cable. The idea behind the code in Part 3 of Listing 1 is to send the initial "AT <Enter>" and get the "OK" response, which will

## LISTING 1

```
#define ATCMDRSP_SP      D                //set to serial port A, B, C, D, E, or F
#define DINBUFSIZE       255             //PC1 = Rx/D -- Xbee pin 2 = Dout
#define DOUTBUFSIZE      127             //PC0 = Tx/D -- Xbee pin 3 = Din
#define SERD_RTS_PORT    PCDR            //RTS is output flowcontrol
#define SERD_RTS_SHADOW  PCDRShadow
#define SERD_RTS_BIT      2              //PC2
#define SERD_CTS_PORT    PCDR            //CTS is input flowcontrol
#define SERD_CTS_BIT      3              //PC3
#define DEFAULTBAUD      9600L           //xbee factory default baud rate
```

\*\*\*\*\*

Part 2..

```
brdInit();
serOpen(ATCMDRSP_SP,DEFAULTBAUD);
serFlowCtrlOn(ATCMDRSP_SP);                //enable flow control
serWrFlush(ATCMDRSP_SP);
serRdFlush(ATCMDRSP_SP);
```

\*\*\*\*\*

Part 3..

```
printf("Trying DEFAULTBAUD (%ld) ",DEFAULTBAUD);
if(xb_atModeOn(1500)<0)                      // if fails try 115200
{
    printf("FAILED, trying (115200L) ");
    serOpen(ATCMDRSP_SP,115200L);
    serWrFlush(ATCMDRSP_SP);
    serRdFlush(ATCMDRSP_SP);
    if(xb_atModeOn(1500)<0)
    {
        printf("\nTried 9600 baud and 115200 baud and Failed\n");
        exit(0);
    }
}
printf("SUCCESS\n");
```

■ **LISTING 1. Another big plus for Rabbit is that their code is really easy to read and understand. For instance, ATCMDRSP\_SP or AT CoMmanD RESponse\_Serial Port is assigned to serial port D on the Rabbit general-purpose I/O Port C.**



## PARALLEL PORT C

| PIN | PRIMARY FUNCTION |        |       | ALTERNATE FUNCTION |       | CAPABILITY |
|-----|------------------|--------|-------|--------------------|-------|------------|
|     | DEFAULT          | OUTPUT | INPUT | OUTPUT             | INPUT |            |
| PC7 | ←                |        | INPUT |                    | RXA   | ←          |
| PC6 | →                | OUTPUT |       | TXA                |       | →          |
| PC5 | ←                |        | INPUT |                    | RXB   | ←          |
| PC4 | →                | OUTPUT |       | TXB                |       | →          |
| PC3 | ←                |        | INPUT |                    | RXC   | ←          |
| PC2 | →                | OUTPUT |       | TXC                |       | →          |
| PC1 | ←                |        | INPUT |                    | RXD   | ←          |
| PC0 | →                | OUTPUT |       | TXD                |       | →          |

■ **FIGURE 3.** This is no different from any other microcontroller you've had to deal with. Every microcontroller has its own general-purpose I/O quirks and the Rabbit is no different in that department.

verify that the correct baud rate is being used. Baud rates of 9600 bps and 115200 bps are attempted. If things blow up during the process, the application will halt in its tracks. The 1500 in the XBee\_atModeOn argument is the time required to expire (Guard Time) before placing the XBee module in AT command mode. A "1" is returned if the xb\_atModeOn function completes successfully.

To give you a better idea of how the XBee library functions work and what they do, let's execute a bunch of arbitrary XBee library functions on the PAN Coordinator's Rabbit and see what they do. We'll also execute some useful functions aimed at the PAN Coordinator. I've captured the results of the execution of the functions in Listing 2, as well. The \_atCmdRsp lines are showing actually what is being offered up on the serial port.

Note that in Listing 2, we are matching up the PAN Coordinator's RF Module interface board configuration to the application's hardware configuration using a series of xb\_setDX function calls. We also could have foregone using X-CTU to assign a Node Identifier as the xb\_setNI function call in Listing 2 does that for us.

The next code sequence shown below is exclusive to XBee modules operating in a network. The xb\_getND function fires off a data sequence that attempts to locate all of the XBee nodes in radio range. The ND (Node Discover) function searches the network for XBee modules and if found returns their 16-bit short address, their 64-bit IEEE address, the signal strength, and their Node Identifier.

```
int  rval,samples,chi,dio,adc;
char data[1024];           // must be large enough to hold
                           // all discovered nodes

char *ptr;

printf("Discovering Nodes... \n");
xb_atModeOn(1500);
waitfor((rval=xb_getND(data)));
if(rval>0)
{
    printf("  Found nodes:\n");
    ptr = strtok(data,"\r"); // first call to
                           // strtok needs buffer
    while(ptr != NULL)
    {
        printf("  MY: %s",ptr);
        printf("  SH: %s",strtok(NULL,"\r"));
        printf("  SL: %s",strtok(NULL,"\r"));
        printf("  DB: %s",strtok(NULL,"\r"));
        printf("  NI: %s",strtok(NULL,"\r"));
        printf("\n");
        // see if there is another node
        ptr = strtok(NULL,"\r");
    }
    printf("End\n");
}
```

When a node is discovered, it associates with the PAN Coordinator in the standard IEEE 802.15.4 fashion and ships back the data package I captured in Sniffer Capture 1 (available on the *Nuts & Volts* website at [www.nutsvolts.com](http://www.nutsvolts.com)). Let's see if we can figure out what is going on here. Here's the Dynamic C STUDIO printout:

## LISTING 2

```
*Get the channel number
xb_getCH();
_atCmdRsp: Tx=ATCH
_atCmdRsp: Rx=B

*Get the 64-bit IEEE 802.15.4 assigned address
xb_getSH();
_atCmdRsp: Tx=ATSH
_atCmdRsp: Rx=0013A200

xb_getSL();
_atCmdRsp: Tx=ATSL
_atCmdRsp: Rx=4008DD8D

* Set the Node ID
xb_setNI("DIO-COORD\r");
_atCmdRsp: Tx=ATNI DIO-COORD
_atCmdRsp: Rx=OK

*Setup I/O for the XBee RF Module Interface Board
xb_setD0(5); // out high
_atCmdRsp: Tx=ATD0 05
_atCmdRsp: Rx=OK

xb_setD1(5); // out high
_atCmdRsp: Tx=ATD1 05
_atCmdRsp: Rx=OK

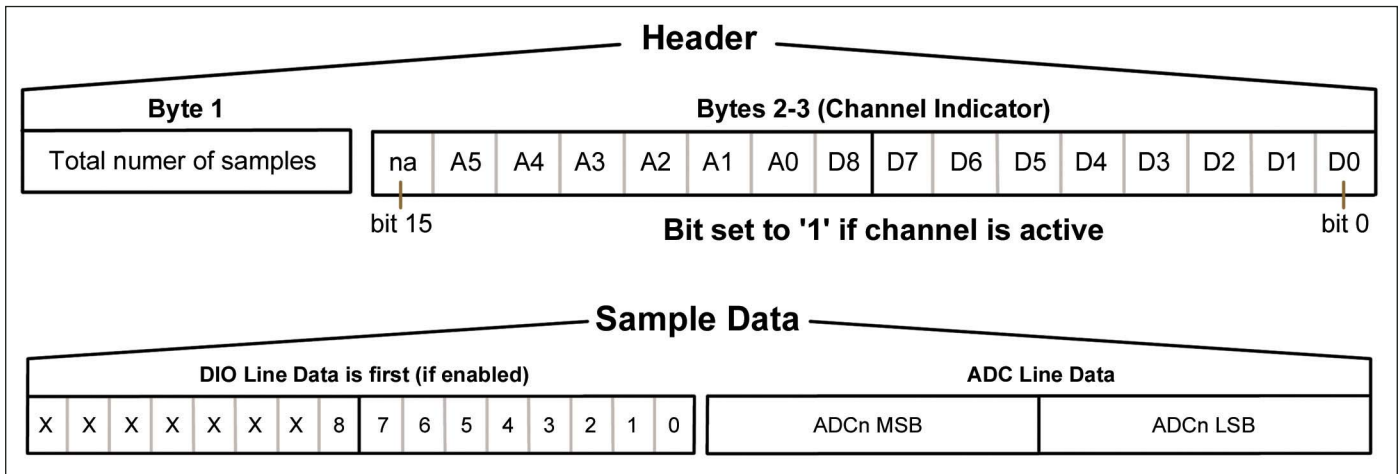
xb_setD2(3); // S1 pushbutton
_atCmdRsp: Tx=ATD2 03
_atCmdRsp: Rx=OK

xb_setD3(2); // ADC3 for battery monitoring
_atCmdRsp: Tx=ATD3 02
_atCmdRsp: Rx=OK

xb_setD4(3); // S2 pushbutton
_atCmdRsp: Tx=ATD4 03
_atCmdRsp: Rx=OK

*Exit AT Mode
xb_atModeOff();
_atCmdRsp: Tx=ATCN
_atCmdRsp: Rx=OK
```

■ **LISTING 2.** The \_atCmdRsp lines are showing what actually is being offered up on the serial port in response to the function calls.



Discovering Nodes...

Found nodes:

MY: FFEE SH: 13A200 SL: 4008DD58 DB: 28 NI:  
STARCHILD-1  
End

And, here's the hex dump of the data array gleaned from the response frame sent by the XBee End Device:

```
dbf2: 46 46 46 45 0D 31 33 41 32 30 30 0D 34 30 30 38
FFFE13A2004008
dc02: 44 44 35 38 0D 32 43 0D 53 54 41 52 43 48 49 4C
DD582CSTARCHIL
dc12: 44 2D 31 0D 00 00 00 00 00 00 00 00 00 00 00 00
D-1
```

All of the data fields in the data array are delimited by a carriage return character (0x0D- "\r"). The strtok (string token) function in Code Snippet R.5 is used to parse the data fields of the data array using the carriage return as the delimiter. The only piece of data that may not be obvious is the signal strength value, which is converted to decibels before being output to the Dynamic C STUDIO debugging window. A NULL (0x00) indicates the end of an End Device's data structure. Multiple End Device data structures can be held in the data array, which is allocated as 1024 bytes.

Now, let's look at some code that produces input samples from the PAN Coordinator's general-purpose I/O. The sequence of events taking place in the code below work on the general-purpose I/O setup we programmed into the PAN Coordinator XBee node earlier. This code could also be run on the ZigBee End Device and transmitted to the PAN Coordinator. In this case, the input samples would more than likely be used by a personal computer collecting data from the PAN Coordinator.

■ **FIGURE 4.** Nothing to it. Just match up the bits in the channel indicator to the bits in this figure. The DIO bits correspond to the setup we performed in Listing 2. The analog-to-digital converter value speaks for itself here.

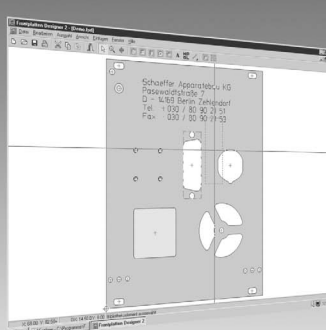
```
printf("Forcing input samples for the local XBee...\n");
xb_getIS(data); // force sample, get ADC
samples = atoi(strtok(data, "\r"));
chi = atoi(strtok(NULL, "\r"));
dio = atoi(strtok(NULL, "\r"));
adc = atoi(strtok(NULL, "\r"));
printf(" samples(%04X) channel Indicator(%04X)\n", samples, chi, dio, adc);
xb_atModeOff();
```

Here's what the data gathered from the PAN Coordinator's general-purpose I/O pins looks like in Rabbit microprocessor memory:

```
dbf2: 31 0D 31 30 31 37 0D 30 30 30 0D 31 45 37 0D 00
1101700001E7
```

## Front Panels?

Download the free »Front Panel Designer«  
to design your front panels in minutes



Order your front panels online  
and receive them just in time

[www.frontpanelexpress.com](http://www.frontpanelexpress.com)

Unrivaled in price and  
quality for small orders



# Amazing Devices

www.amazing1.com

## Laser Modules

All laser modules operate from 3 volts and include built in optics providing a parallel beam of 1mr or less. Includes instructions on safety requirements for FDA full compliance

### Red - Class IIIa

|                               |         |
|-------------------------------|---------|
| LM650P3 - 3mw 650nm 12x45mm   | \$14.95 |
| LM650P5 - 5mw 650nm 12x45mm   | \$24.95 |
| LM630P3 - 3mw 630nm 10.5x45mm | \$34.95 |

### Red - Class IIIb

|                               |          |
|-------------------------------|----------|
| LM650P10 - 10mw 650nm 12x51mm | \$99.95  |
| LM650P30 - 30mw 650nm 12x51mm | \$249.95 |

### Green - Class IIIa

|                             |         |
|-----------------------------|---------|
| LM532P5 - 5mw 532nm 12x45mm | \$49.95 |
|-----------------------------|---------|

### Infrared - Class IIIb

|                               |         |
|-------------------------------|---------|
| LM980P30 - 30mw 980nm 12x30mm | \$49.95 |
|-------------------------------|---------|

### Laser Diode Visible Red - Class IIIb

|                                  |         |
|----------------------------------|---------|
| LD630-P10 - 10mw 635nm 5mm diode | \$29.95 |
|----------------------------------|---------|

## High Voltage Capacitors

### Ceramic capacitors for voltage multipliers, etc.

|  |       |
|--|-------|
| 22/6KV - 22 pfd 6kv .28" x 1.7"        | \$35  |
| 50/6KV - 50 pfd 6kv .325" x .18"       | \$45  |
| 100/6KV - 100 pfd 6kv .46" x .17"      | \$65  |
| 200/3KV - 200 pfd 3kv .3" x .25"       | \$45  |
| 270/3KV - 270 pfd 3kv .3" d x .25"     | \$45  |
| 470/10KV - 470 pfd 10kv .35" d x .25"  | \$75  |
| 1000/20KV - 1000 pfd 20kv .5" d x .37" | \$225 |
| .01/2KV - .01 mfd 2kv .63" x .13"      | \$50  |

## Energy Storage Capacitors

### Electro-kinetics, wire exploding, can crushing, emp, etc.

|  |          |
|--|----------|
| 25M/5KV - 25 mfd 5kv 312J 10x4x3 can     | \$100.00 |
| 32M/4.5KV - 32 mfd 4.5kv 324J 9x4x2 can  | \$170.00 |
| 10002M/2KV - 1000 mfd 2kv 2K J 4x8x7 can | \$299.00 |
| 1.3M/100KV - 1.3 mfd 100kv 6500J case    | \$750.00 |

## High Voltage Transformers

### Includes circuit schematics on how to use.

|  |         |
|--|---------|
| 28K089 - 7kv 10ma 30khz 9-14v 1" cube  | \$19.95 |
| 28K074 - 4kv 15ma 30khz 9-14v 1" cube  | \$17.95 |
| 28K077 - 2kv 10ma 30khz 7-9v .7x1.25   | \$9.95  |
| CD25B - 20 kv trigger pulse 1 x 1.25   | \$16.95 |
| CD45 - 40 kv trigger pulse 1.25 x 1.25 | \$18.95 |
| TRAN1035 - 10kv 35ma bal output        | \$39.95 |
| FLYLABURN - 10kv 60ma end grd          | \$49.95 |
| FLYEXP - 4 misc flybacks               | \$24.95 |
| FLYHP - High power large flyback       | \$34.95 |

## High Volt/Freq Modules

### 12 vdc with instructions on how to use.

|                                   |          |
|-----------------------------------|----------|
| MINIMAX1 - 1kv 15ma 35khz         | \$17.95  |
| MINIMAX2 - 2kv 10ma 50khz         | \$17.95  |
| MINIMAX3 - 3kv 10ma 35khz         | \$19.95  |
| MINIMAX7 - 7kv 10ma 35khz         | \$34.95  |
| SS01S - 1 to 7kvac for ozone      | \$24.95  |
| GRADIRIV10 - 7.5kv 15ma 35khz adj | \$79.50  |
| PVM300 - 20kv 25ma 115vac input   | \$179.95 |

## High Volt DC Modules

### 12 vdc with instructions on how to use.

|                                     |         |
|-------------------------------------|---------|
| PBK40 - 10 kv 100ua 9 vdc in        | \$34.95 |
| CHARGE10 - 10kv 2.5 ma              | \$59.95 |
| SHK10 - 2kv 10 ma shocker           | \$39.95 |
| TRIG10 - 20 kv trigger/shock pulses | \$54.95 |
| SS016S - +20kv 100ua                | \$29.95 |
| SS010S - -20kv for neg ions         | \$24.95 |

## Parts for Tesla Coils

### Includes plans for two of our coils. Parallel for 60&120ma.

|   |          |
|---|----------|
| 4KV/.03 - 4kv 30ma 60hz floating output | \$59.95  |
| 6KV/.02 - 6.5kv 20ma 60hz float output  | \$59.95  |
| 9KV/.03 - 9kv 30ma 60hz midgrd output   | \$79.95  |
| 12KV/.03 - 12kv 30ma 60hz midgrd output | \$109.95 |
| 15KV/.03 - 15kv 30ma 60hz midgrd output | \$139.95 |
| 14.4KV/.5A - 14.4kv .5amp pole pig      | \$699.95 |

### Spark Gaps and Electrodes

|  |          |
|--|----------|
| SPARK1 - Fan cooled dual gap 3/8" tungsten                 | \$149.95 |
| SPARK05 - Single gap 1/4" tungsten                         | \$49.95  |
| TUNG141B - 1/4" x 1" pair electrodes with holders tungsten | \$149.95 |
| TUNG38 - 3/8" x 2" pair electrodes with holders tungsten   | \$59.95  |

### Toroidal Terminals

|                                     |          |
|-------------------------------------|----------|
| T08 - 8 x 2" Spun Aluminum Toroid   | \$59.95  |
| T012 - 12 x 3" Spun Aluminum Toroid | \$79.95  |
| T024 - 24 x 6" Spun Aluminum Toroid | \$399.95 |
| T030 - 30 x 7" Spun Aluminum Toroid | \$525.95 |

See website for more data on above items

Minimum order is \$25.00. Volume pricing available

Information Unlimited, Box 716, Amherst, NH 03031 USA  
Orders: 800-221-1705 Info: 603-673-6493 Fax: 603-672-5406  
Email: riannini@metro2000.net

And, here's the resultant printout in the Dynamic C STUDIO debugging window:

Forcing input samples for the local XBee...

```
samples(0001) channel Indicator(1017) active I/Os(0000) ADC3(01E7)
```

You can readily see the relationship between the data fields in the hex dump, the argument fields of the printf function in the code, and the Dynamic C STUDIO printout. This data was not presented to the RF portion of the XBee and therefore there's no Daintree Networks SNA capture to show. So, let's figure out how the data in the Dynamic C STUDIO window came to be.

The first two data indicators are easily explained with a look at the top half of Figure 4. If you simply match up 0x1017 — which is the channel indicator value — to the bit layout in Figure 4, you'll find that in Listing 2 we actually defined and set up every one of the active general-purpose I/O channels in our code.

Pushbutton switches on the XBee RF Module interface board are connected to DIO lines D2 and D4. Thus far, I have pressed no buttons as the active I/Os value is equal to 0 (zero). To provide you with a better example of how the DIO fields work, I captured a session in which I depressed the S1 and S2 pushbuttons on the XBee RF Module interface board respectively. Here's what the Dynamic C STUDIO window showed:

Discovering Nodes...

Found nodes:

```
MY: FFFE SH: 13A200 SL: 4008DD58 DB: 32 NI: STARCHILD-1
```

End

Forcing input samples for the local XBee...

```
samples(0001) channel Indicator(1017) active I/Os(0004) ADC3(01E7)
```

Discovering Nodes...

Found nodes:

```
MY: FFFE SH: 13A200 SL: 4008DD58 DB: 43 NI: STARCHILD-1
```

End

Forcing input samples for the local XBee...

```
samples(0001) channel Indicator(1017) active I/Os(0010) ADC3(01E6)
```

If you match up the 0x0004 with the DIO layout in the lower half of Figure 4 and then correlate that back to the code in Listing 2, you'll see that I was holding down the S1 pushbutton, which is tied to DIO2. Depressing S2 produced an active I/O value of 0x0010 that directly relates to DIO4 in Figure 4.

## INSTANT ZIGBEE

We by no means covered all of the functionality of the Rabbit ZigBee/802.15.4 Application Kit and the Dynamic C library code that accompanies it. However, we did see how easy it was to get a couple of XBee ZigBee nodes up on a ZigBee PAN.

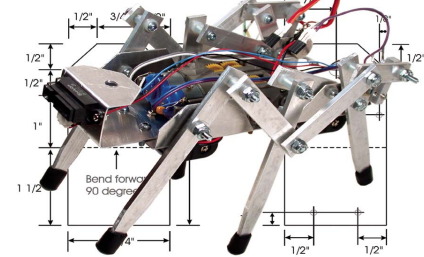
It's pretty obvious that the firmware loaded on the XBee modules is an official IEEE 802.15.4 MAC and PHY implementation rolled in with some proprietary XBee functionality. The XBee modules are designed to work right out of the box and so are the Dynamic C-backed Rabbit XBee RF interface boards. Although it is always good to have some background knowledge, no prior IEEE 802.15.4 or ZigBee experience is necessary to assemble a ZigBee PAN using XBee modules and Rabbit microprocessors. That makes the XBee/Rabbit combination easy to incorporate into your ZigBee Design Cycle. **NV**

## SOURCES

■ **Rabbit Semiconductor** — Rabbit ZigBee/802.15.4 Application Kit — [www.rabbitsemiconductor.com](http://www.rabbitsemiconductor.com)

■ **Daintree Networks SNA/Daintree Networks** — IEEE 802.15.4/ZigBee Sniffer Software — [www.daintree.net](http://www.daintree.net)

■ **MaxStream** — XBee and XBee-Pro — [www.maxstream.net](http://www.maxstream.net)



■ BY PHIL DAVIS

## MOTOR TEST LAB — PART 1

**BEING AN AMATEUR ROBOTICIST, I am always looking for parts of varying kinds from which to build robots and, since most of the bots I like to construct are mobile, one of the major requirements are brushed DC motors.**

**Y**ou can find brushed DC motors just about everywhere; new on the Internet, on eBay, on Internet sites which sell surplus components, and possibly at your local walk-in surplus store. The thing is, unless you buy it new — which can be expensive — you have no real idea about the capability of the motor. For example, how do you know what the ‘stall’ current is so you can use an H-bridge of the right size, or how do you know what the max RPM is etc., things which can make or break your bot.

The best thing you can do is get one in your hands and test it.

For several years, I’ve been using my own crude test setup using analog meters, as shown in Photo 1. Using this setup, not only can I charge my LiPol batteries, I can connect the meters in series with a motor and battery, switch to ‘monitor’ mode, and watch the amps and voltages change as the motor is running.

This has served me well, but recently I decided I wanted to understand a little bit more about the motors I use, especially things like:

- High-end RPM
- A PWM to RPM graph
- An RPM to current-to-voltage graph
- Torque

■ PHOTO 2. Power Analyzer Pro package.



- Performance under load
- Etc.

Certainly these questions are more than my simple setup can easily offer, so I set out to look for something a bit more capable and with which I could build my Homemade Motor Test Lab.

Relative to the robotics hobby, the radio control hobby is much more mature. Radio control enthusiasts have been doing their thing for tens of years. That’s not to say that roboticists haven’t, it’s just that the R/C hobby has been more commercialized. Because of this, there are lots of R/C components readily available in the marketplace such as battery packs, servos, etc., and many of these are easily adaptable for robots.

### THE DC MOTOR POWER ANALYZER

Searching through the R/C world, I

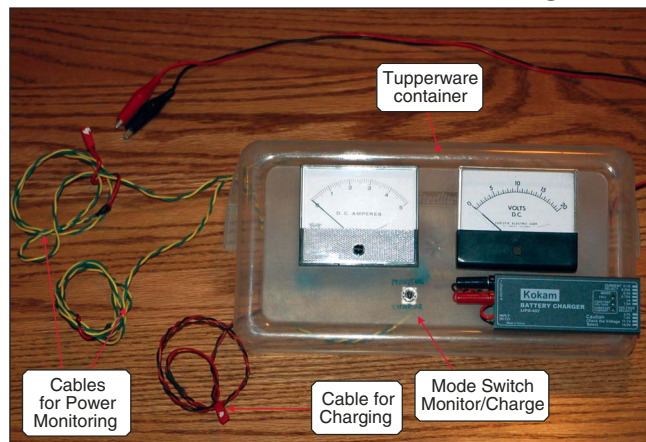
came across a product by Medusa Research, Inc., called the Power Analyzer Pro and as my friend says, this had the “smell of almost done.” My thoughts were that I could use this device as the center piece of my test lab and be in production in short order.

The Power Analyzer Pro comes as a package with a number of items (see Photo 2):

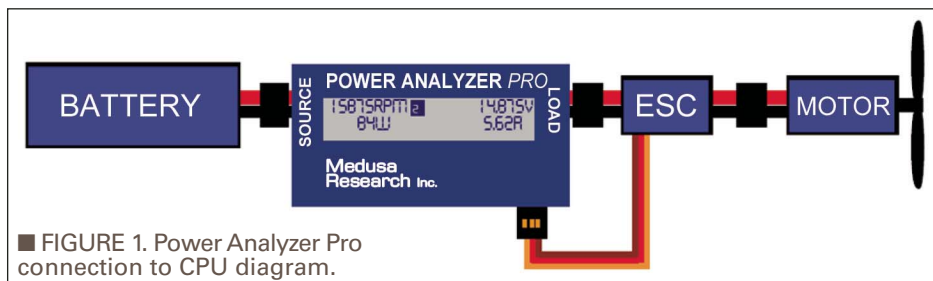
- The analyzer device itself
- A USB cable for connecting the device to your PC
- An electronic scale
- An IR emitter/receiver sensor and cable for measuring RPM
- Two temperature sensors and cables

As you can see, this is quite a

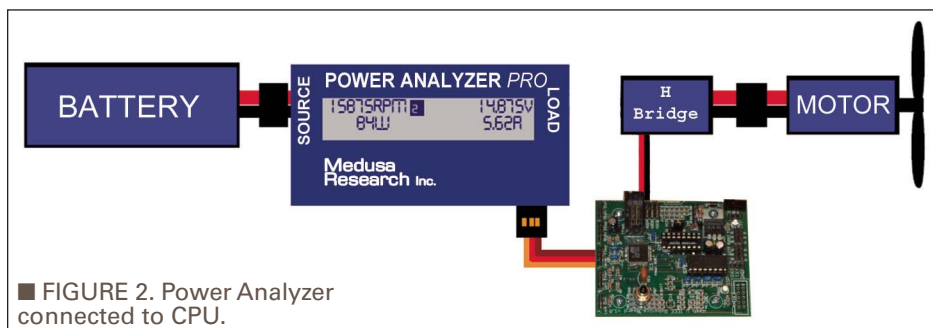
■ PHOTO 1. Homemade test setup with analog meters.







■ FIGURE 1. Power Analyzer Pro connection to CPU diagram.



■ FIGURE 2. Power Analyzer connected to CPU.

complete package designed primarily for measuring the current, voltage, RPM, and torque of an electric flight

package of an R/C airplane. The temperature sensors are, for example, measuring the temperature of the

## LISTING 1. Interrupt routine.

```
//-----
// Function: Int 0 interrupt handler
// Action:   Used to measure a 1-2ms input pulse
// Comment:  A smoothing filter might make this work a little better
//           eg. a 4 or 5 length moving average
//-----
SIGNAL (SIG_INTERRUPT0)
{
    if(PIND & 0x04) {                // is pin high
        PulseWidth_Start = TCNT2;    // get start of time period
    } else {
        PulseWidth_End = TCNT2;      // get end of time period
        if(PulseWidth_Start > PulseWidth_End) {
            RC_Width = (0xff - PulseWidth_Start) + (PulseWidth_End);
        } else {
            if(PulseWidth_End > PulseWidth_Start) {
                RC_Width = PulseWidth_End - PulseWidth_Start;
            }
        }
    }

    // RC_Width will now have a range of 128 - 255 (in theory)
    Width_raw = RC_Width;            // get for debug purposes

    if (RC_Width <= 127)              // clip as timing may be off slightly
        RC_Width = 128;

    if (RC_Width >= 255)              // clip as timing may be off slightly
        RC_Width = 255;

    RC_Width = RC_Width - 128;        // scale to 0 - 127

    RC_Width = RC_Width + 128;        // scale for H-Bridge PWM use
    RC_Width_cpy = RC_Width;         // make copy for use in tasks.
}
}
```

battery pack and/or the can of the motor. The scale is for measuring thrust from the prop of the motor being tested. The Power Analyzer is quite a sophisticated device and when connected to your PC with the provided USB cable, it is capable of remotely controlling a DC motor and of measuring and graphing many of the critical parameters. Just what I want!

My task now was to take the analyzer and build it into a system for testing my ad hoc motors. If you look at the connection diagram in Figure 1, you can see an example of how the analyzer might be used in an RC application. Of particular note is the ESC. An ESC in the R/C world is an electronic speed control which sits between the battery and the motor and is connected to an output from the R/C receiver allowing the user to control motor speed remotely by moving the throttle on the transmitter.

However, from Figure 1, you can see that in this case the ESC is not connected to an R/C receiver, but is connected to an output from the Power Analyzer. This output emits exactly the same style of PWM (Pulse Width Modulation) as that emitted by an R/C receiver and so is able to programmatically control the speed of the motor. This is obviously great for testing purposes.

## H-BRIDGES AND ESCs

Hmmmm. Thing is, in the robotics world, we tend to use H-bridges not ESCs and worse yet, the PWM we use to drive an H-bridge is quite different than that emitted by an R/C receiver.

Let's look in more detail at the PWM generated by an R/C receiver which is intended as input to a servo or ESC. The width of the pulse of this signal is typically between one millisecond and two milliseconds long; in the case of a throttle, 1 ms corresponds to off and 2 ms corresponds to full speed. The second consideration is the frequency at which this pulse is emitted every second. Typically, the pulses come every 20 to 30 milliseconds which means the frequency is in the range of 30 to 50 times per second; probably closer to 40, that is 40 Hz.

On the other hand, the PWM we drive an H-bridge with is quite different. The width of the pulse goes from zero time to the time interval defined by the frequency. The frequency used to drive an H-bridge varies greatly, from a few kHz to 100 kHz or more. Quite a difference from the PWM used to drive RC devices.

To make this system work, I needed to convert the R/C PWM to a PWM more acceptable to the H-bridge I wanted to use. This involved taking the output from the Power Analyzer and feeding it into my own CPU board, converting it to the PWM style I wanted, and then sending it back out to an H-bridge. See Figure 2 for the configuration of this system.

## RC PWM TO H-BRIDGE PWM

The CPU board I am using is based around an Atmel Mega32. Converting of the PWM from one form to another required the writing of a small interrupt routine, which would measure the width of each individual pulse, scale it accordingly, and send it out the PWM hardware of the Mega32.

Interrupt zero on the CPU was set to generate an interrupt on either the leading or trailing edge of a pulse. The interrupt routine reads the value of a timer at the beginning of the pulse and again at the end of the pulse and subtracts the two to give the pulse width. Please see Listing 1 for the source of this routine. The timer used for the width measurement was pre-scaled and I should mention that the H-bridge is set so that 128 corresponds to zero and 255 corresponds to max, in a specific direction.

Since I've been using FreeRTOS for the last several projects, I saw no reason not to use it in this project, even though the task required was very simple. Please see Listing 2 for the source of this task. This task

■ PHOTO 4. Physical layout of the Motor Test Lab, oblique view.

## LISTING 2. FreeRTOS task to output PWM.

```
//-----
// Function: test_motors -- (FreeRTOS Task)
// Action:   drive PWM
//-----
void test_motors(void *pvParameters) {
    (void) pvParameters;                                // The parameters are not used.

    portTickType xLastWakeTime;
    const portTickType xFrequency = 4;                // delay 5 milisec ticks (4)

    drive_pwm(128);                                    // set to zero speed

    xLastWakeTime = xTaskGetTickCount();                // Get base ClockTick for delay timer

    // Cycle for ever
    for(;;) {

        drive_pwm(RC_Width_cpy);                        // output PWM to H-Bridge

        vTaskDelayUntil(&xLastWakeTime, xFrequency);

    }
}
```

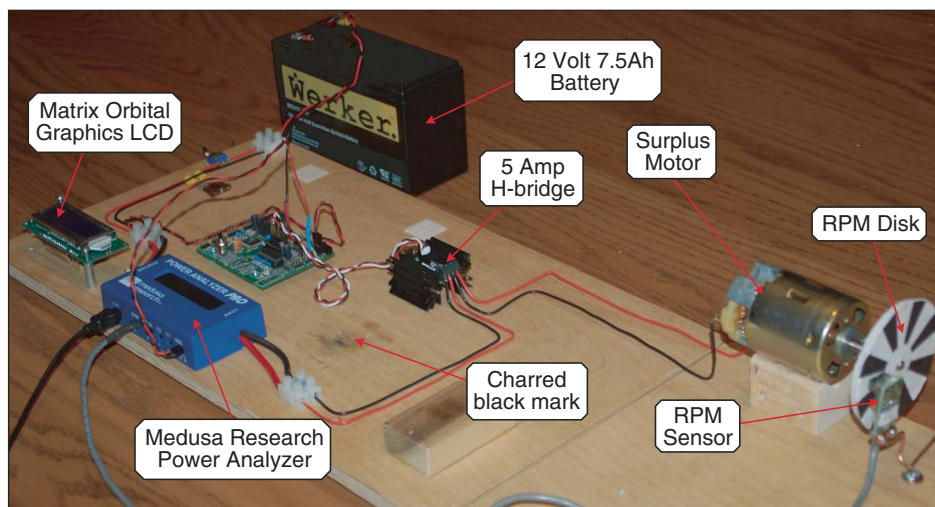
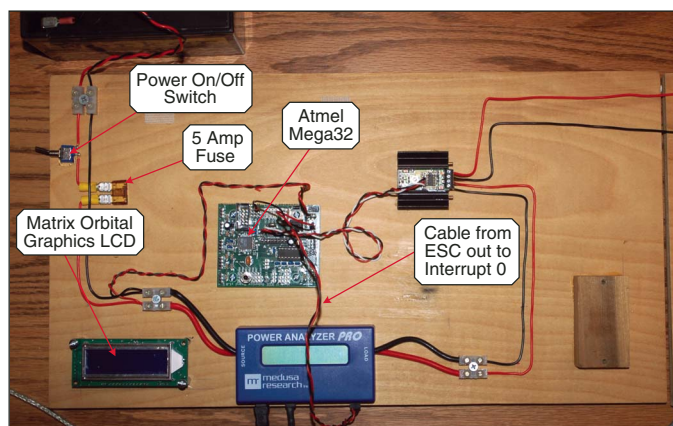
updates the PWM hardware 50 times a second with the current pulse width as generated by the interrupt routine. The PWM hardware on the Mega32 was set to a frequency of approximately 8 kHz.

## BUILDING THE TEST LAB

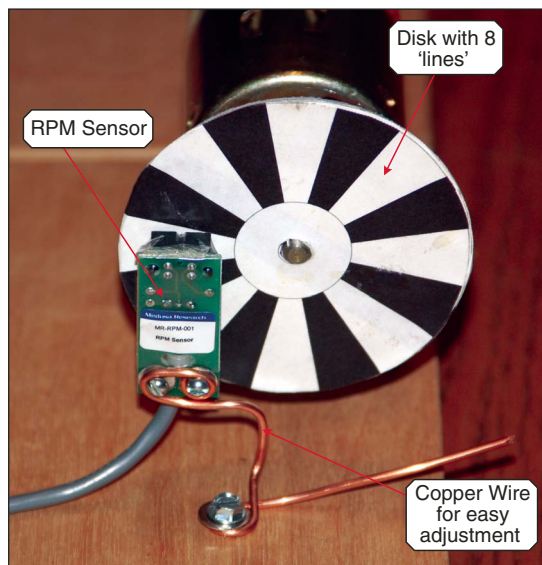
For neatness' sake, I decided to

■ PHOTO 3. Physical layout of the Motor Test Lab, top view.

lay the components out on a piece of plywood, to keep everything in place and to make it easy to move around. Please see Photos 3 and 4 for the







■ PHOTO 5. Motor with disk and RPM sensor.

The CPU board has a set of wires going to a five amp H-bridge. I used to have two identical H-bridges, the second one being where the black charred spot is. After accidentally reversing the polarity of the battery and letting the smoke out of the H-bridge (rather loudly, I might add), I quickly installed a five amp fuse. The CPU board is also connected via I<sup>2</sup>C to a Matrix Orbital LCD (I've removed the connecting wires for now as they were rather long).

From the H-bridge, there is a pair of wires running to the current motor under test. This motor is mounted on a separate board so I can exchange motors, drill holes, and manhandle it without disturbing the electronics.

The motor in the photo is one I purchased at our local surplus store, Electronics Exchange. Aside from feeling the weight and noticing the size, I had no idea about its performance when I bought it. The can of the motor is approximately three inches long and two inches in diameter and the cost was \$6.

The H-bridge, on/off switch, and motor are all fixed in place

with a hot glue gun.

## MEASURING THE RPM

The Power Analyzer does an excellent job of internally measuring the voltage, the current, and the applied throttle (PWM). However, to measure the actual RPM, it needs to have an external sensor.

This sensor is an IR emitter/collector pair and in the primary RC application of the Power Analyzer, it is used to measure the RPM of an airplane propeller. The software provided is quite smart in that it allows the selection of the number of blades on the prop (e.g., two blades or four blades or seven, in the case of a ducted fan) and scales the RPM appropriately. This gave me the idea of making a disk out of foam board, and sticking a cut-out circle of paper printed with a pattern of lines which I created with a drawing program onto it.

In Photo 5, you can see I made this disk with 16 lines. As it turned out, this worked very well and, with one of the features of the Power Analyzer software, I was able to include a formula which divided the measured RPM by eight, simulating a two blade propeller.

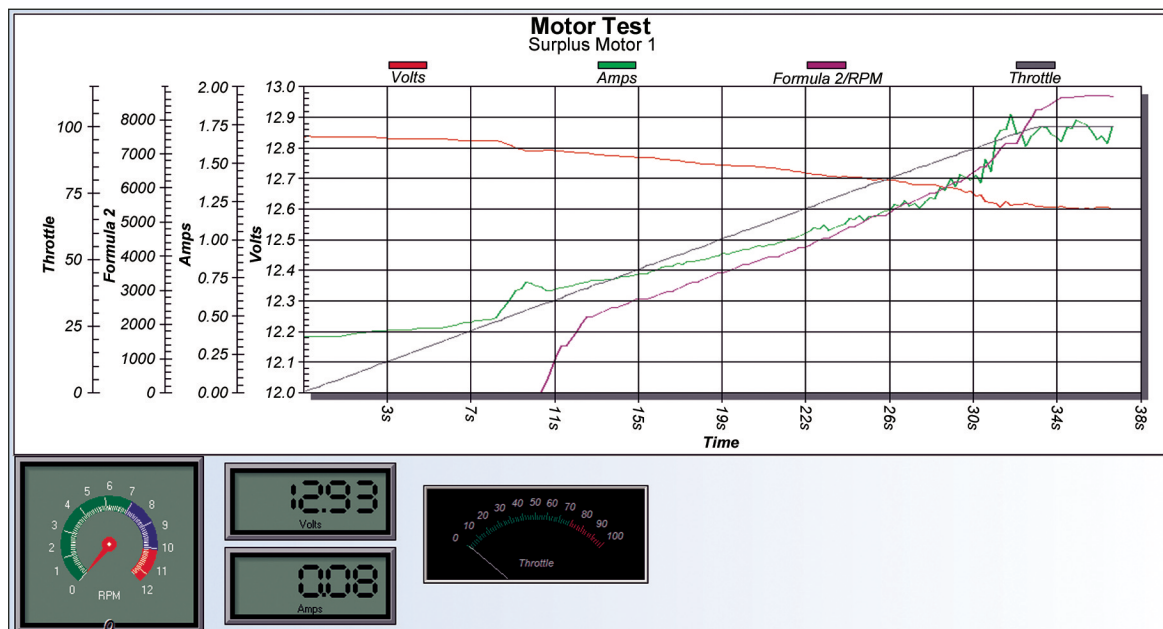
Why you might ask, did I use 16 lines instead of two or even four and let the Power Analyzer software

manage the RPM count? The Analyzer was designed to measure very high speed propellers and has a minimum resolution of 25 RPM. Since I want to be able to test gear motors — which at low PWM, may be turning at one or two RPM — I needed

finished layout. The boards have rubber feet so as not to scratch any surfaces such as the kitchen table — an important feature.

As you can see, the Power Analyzer has several cables coming out of the side facing the camera. One is the USB cable going to my laptop, one is the cable going to the RPM sensor (more on that later), and one is the cable from the Analyzer ESC output going to interrupt zero on my CPU board.

Power is coming in from a 12 volt 7.3 Ah battery on the top left to an on/off switch and a five amp fuse; from there, it feeds the analyzer and the CPU board.



■ PHOTO 6. Preliminary result of a surplus motor.

to trick the software into thinking that there were more revolutions than there actually were. A disk with 16 lines should allow me to read 1-2 RPM.

## SUMMARY

This month, I wanted to go over the basic construction of my lab, detailing the various aspects and issues of its construction. As a teaser for next month, Photo 6 shows some preliminary results of the surplus motor shown in the previous photos. From the graph, it turns out that the motor — when running flat out at 100% PWM — draws about 1.7 amps to 1.8 amps and has a high-end RPM of approximately 8,300, which I must admit really surprised me. When you try to turn the shaft of this motor with your hand, you can feel the strong cogging caused by the powerful magnets. This is evidenced by the fact the motor does not start to turn until about nine seconds into the test where the PWM is at about 20-30% and the current at .5 amps to .6 amps.

Next month, I intend to talk about how the lab worked out when measuring the performance of several different motors, with and without gears, looking at various parameters such as RPM, current, torque, Kt, Kv, etc. Hopefully, we'll also learn a lot about 'Prony Brakes,' so stay tuned. **NV**

## RESOURCES

■ **Medusa Research Power Analyzer** — [www.medusa-products.com](http://www.medusa-products.com)

■ **Matrix Orbital LCD** — [www.matrixorbital.com](http://www.matrixorbital.com)

■ **Electronics Exchange Surplus Motor** — [www.electronics-exchange.com](http://www.electronics-exchange.com)

■ **FreeRTOS** — [www.freertos.org/](http://www.freertos.org/)

■ **WinAVR** — <http://winavr.sourceforge.net/>

■ **AVRstudio** — [www.atmel.com/dyn/products/tools\\_card.asp?tool\\_id=2725](http://www.atmel.com/dyn/products/tools_card.asp?tool_id=2725)

CALL  
TOLL-FREE  
TO ORDER

(800) 292-7711 [www.cs-sales.com](http://www.cs-sales.com)

# C&S SALES

CALL OR  
E-MAIL US  
FOR OUR  
**FREE**  
CATALOG!

### Elenco® Snap Circuits

Elenco's new Snap Circuits make learning electronics fun and easy. Just follow the colorful pictures in our manual and build exciting projects, such as: FM radios, digital voice recorders, AM radios, burglar alarms, doorbells, and much more! You can even play electronic games with your friends. All parts are mounted on plastic modules and snap together with ease. Enjoy hours of educational fun while learning about electronics. No tools required. Uses "AA" batteries.

**6 versions available.**  
Build up to **750 projects!**  
As low as **\$29.95**



**Great Gift Idea!**

Create  
Your Own  
Exciting  
Experiments

Upgrades and replacement  
parts available at:  
[www.cs-sales.com](http://www.cs-sales.com)

#### 4 Educational Models Available

|  |                 |
|--|-----------------|
| <b>SC-750 - Extreme Version</b> , contains over 80 parts to build over 750 experiments. Includes everything from SC-500 plus experiments in solar, electromagnetism, vibration switches, and 70 computer interfaced experiments..... | <b>\$119.95</b> |
| <b>SC-500 - Pro Version</b> , contains over 75 parts including voice recording IC, FM radio module, analog meter, transformer, relay, and 7-segment LED display. Build over 500 experiments.....                                     | <b>\$89.95</b>  |
| <b>SC-300 - Deluxe Version</b> , contains over 60 parts. Build over 300 experiments.....   | <b>\$59.95</b>  |
| <b>SC-100 - Snap Circuits, Jr.</b> , contains over 30 parts. Build over 100 experiments.....   | <b>\$29.95</b>  |

### Electronic Science Lab

#### Maxitronix 500-in-1 Electronic Project Lab

##### Model MX-909

**Everything you need to build 500 exciting projects!**

- Learn the basics of electronics. 500 different electronic experiments, special lighting effects, radio transmitter and receivers, sound effects, cool games and MORE!
- Includes built-in breadboard and an LCD.
- Explore amplifiers, analog and digital circuits plus how to read schematic diagrams.
- Includes 11 parts.
- Lab-style manual included.
- Requires 6 "AA" batteries.



**\$169**

**MX-908 - 300-in-1 Lab \$69.95**  
**MX-907 - 200-in-1 Lab \$49.95**

**MX-906 - 130-in-1 Lab \$39.95**  
**EP-50 - 50-in-1 Lab \$18.95**

### Elenco® Digital Multimeters

#### Model M-1750



**\$24.95**

- 3 3/4 Digit LCD
- Freq. to 10MHz
- Cap. to 200µF
- AC/DC Voltage
- Current up to 10A
- Audible Cont.
- Diode Test
- Transistor Test
- Overload Prot.

#### Model LCM-1950



**\$59.95**

- Large 1" 3 3/4 Digit LCD
- Autorangeing Freq. to 4MHz
- Cap. to 400µF
- Inductance to 40H
- Res. to 4,000MΩ
- Logic Test
- Diode & Transistor Test
- Audible Continuity Test

**Quantity Discounts Available**

### Elenco® Educational Kits

#### Model RCC-7K

Radio Control Car Kit

**\$27.95**



- 7 Functions
- Transmitter included
- Non-soldering Version

**AK-870 \$27.95**

#### Model AM-780K

Two IC Radio Kit

**\$9.95**



- AM/FM Version
- AM/FM-108K \$29.95

#### Model M-1006K

DMM Kit

**\$18.95**



- 18 Ranges
- 3 1/2 Digit LCD
- Transistor Test
- Diode Test

Visit our website [www.cs-sales.com](http://www.cs-sales.com) to see our assortment.

### Elenco® Test Equipment

#### Elenco® Quad Power Supply

Model XP-581

4 Fully Regulated Power Supplies in 1 Unit



**\$75**  
4 DC Voltages: 3 fixed: +5V @ 3A, +12V @ 1A, 1 variable: 2.5 - 20V @ 2A • Fully regulated & short protected • Voltage & current meters • All metal case

#### Elenco® Frequency Counter

1MHz-3GHz Model F-2800



**\$99**  
• 10 digit LCD display  
• 16-segment RSSI bargraph  
• Resolution to 1Hz  
• Hi-speed (300MHz) direct count  
• Includes NiCd charger and antenna

#### Elenco® Oscilloscopes

"Special"

**\$329**

Probes included \$1325 30MHz

**\$1330 30MHz Delayed Sweep \$459**

**\$1340 40MHz Dual Trace \$469**

**\$1345 40MHz Delayed Sweep \$549**

**\$1360 60MHz Delayed Sweep \$749**

**\$1390 100MHz Delayed Sweep \$999**

#### Elenco® 5MHz Sweep

Function Generator

with built-in 60MHz

Frequency Counter

Model GF-8056 **\$229**



Generates square, triangle, and sine waveforms, and TTL, CMOS pulse.

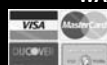
**Guaranteed Lowest Prices**

## C&S SALES, INC.

UPS SHIPPING: 48 STATES 7%  
(Minimum \$7.00)  
OTHERS CALL FOR DETAILS  
IL Residents add 8.75% Sales Tax

150 CARPENTER AVE • WHEELING, IL 60090  
(847) 541-0710 FAX: (847) 541-9904  
E-mail: [sales@cs-sales.com](mailto:sales@cs-sales.com)

**SEE US ON THE WEB → [www.cs-sales.com](http://www.cs-sales.com)**



PRICES SUBJECT TO CHANGE WITHOUT NOTICE

**15 DAY MONEY BACK GUARANTEE**

**2 YEAR FACTORY WARRANTY**



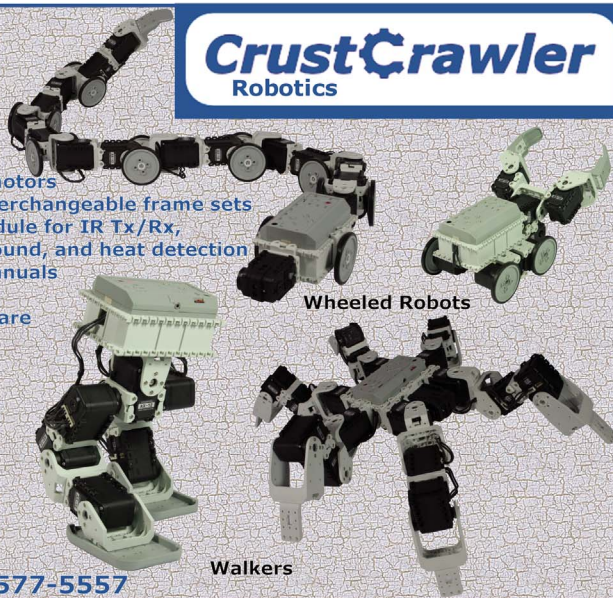
## Build Over 26 Robots from a Single Kit!

**CrustCrawler**  
Robotics

### Kit Features

- A truly modular robotic kit!
- 18 smart network ready TTL servo motors
- Unlimited combinations with 113 interchangeable frame sets
- All-in-one network ready sensor module for IR Tx/Rx, buzzer, directional distance, light, sound, and heat detection
- CD contains sample code, videos, manuals
- Robot Terminal, Motion Editor, and Behavior Control Programmer Software
- Extensive 200 page manual
- Deluxe 19X14X4 carrying case

Bipeds



Wheeled Robots

Walkers

Visit us online [www.crustcrawler.com](http://www.crustcrawler.com) or call 1-(480) 577-5557

## ELECTRONIX EXPRESS

Visit Our Website At  
<http://www.elexp.com>

### RSR-3MHZ SWEEP FUNCTION GENERATORS

6 Waveform Functions, Int/Ext Counter, lin/log sweep

MODEL FG-30  
(No Digital Display)  
\$120.00

MODEL FG-32  
(5 Digit Display)  
\$185.00



### instek<sup>®</sup> OSCILLOSCOPE

MODEL GOS-620  
Dual Channel  
- 20MHZ  
(INCLUDES PROBES)



\$289.00

### DC POWER SUPPLIES

MODEL HY3003 - DIGITAL DISPLAY  
Variable output, 0-30 VDC, 0-3 Amp



\$88.00

MODEL HY3003-3 - TRIPLE OUTPUT  
Two 0-30 VDC, 0-3 Amp variable outputs  
plus 5V 3A fixed. Digital Display.

\$175.00

### Weller<sup>®</sup> SOLDERING STATION

#1 BEST SELLING STATION

MODEL WLC 100  
V0603WLC100



\$36.95

### ROTARY TOOL KIT

Variable speed tool (37,000 RPM) with accessory kit in a hard plastic carry case.  
#V29DR101

\$33.95

### BENCH DMM WITH RS232 INTERFACE

MODEL DM9803R

True RMS, digital and bar graph display, AC/DC Cap, Res, frequency functions. Includes software, AC or DC operation.



\$99.00

### DIGITAL MULTIMETER

32 Ranges - 3 1/2 Digit

MODEL MY-64  
AC/DC Volt/Current, Res. Cap., Frequency. Rubber Holster Included



\$27.95

### ALLIGATOR LEADS

SET OF 10



\$2.10

SOUND SENSOR CAR  
REQUIRES SOLDERING

Reverses direction whenever it detects noise, or touches an obstacle.  
#V3221881



\$8.95

### RSR-3MHZ HIGH PERFORMANCE 3-WIRE IRON

#V060509



\$5.50

### SWITCHES

|                               | 1-9    | 10-99 | 100+ |
|-------------------------------|--------|-------|------|
| 8 POS DIP (V17DIP6SS)         | .90    | .85   | .70  |
| Toggle Mini SPDT (V17TOGSD-M) | 1.15   | .95   | .70  |
| Toggle Mini DPDT (V17TOGDD-M) | \$1.30 | 1.10  | .90  |

### POTENTIOMETERS

|                          | 1-9 | 10-99 | 100+ |
|--------------------------|-----|-------|------|
| Cermet (STS Series)      | 85¢ | 75¢   | 65¢  |
| Multiturn (MTT Series)   | 85¢ | 75¢   | 55¢  |
| Panel Mount (PMA Series) | 95¢ | 65¢   | 55¢  |

Standard Values Available

REQUIRES SOLDERING

Reverses direction whenever it detects noise, or touches an obstacle.  
#V3221881



\$8.95

REQUIRES SOLDERING

Reverses direction whenever it detects noise, or touches an obstacle.  
#V3221881



\$8.95

REQUIRES SOLDERING

Reverses direction whenever it detects noise, or touches an obstacle.  
#V3221881



\$8.95

TERMS: Min. \$20 + shipping. School Purchase Orders, VISA/ MC, Money Order, Prepaid. NO PERSONAL CHECKS, NO COD. NJ Residents: Add 6% Sales Tax.

In NJ: 732-381-8020  
FAX: 732-381-1006

365 Blair Road • Avenel, NJ 07001-2293  
800-972-2225

<http://www.elexp.com>  
email: [electron@elexp.com](mailto:electron@elexp.com)

Order online at:  
[www.melabs.com](http://www.melabs.com)

Development Tools for PIC<sup>®</sup> MCUs  
*microEngineering Labs, Inc.*

Phone: (719) 520-5323  
Fax: (719) 520-1867  
Box 60039  
Colorado Springs, CO 80960

### USB Programmer for PIC<sup>®</sup> MCUs

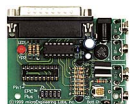
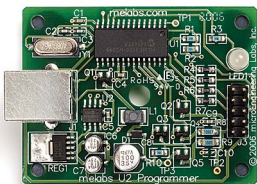
\$119.95  
(with accessories)

RoHS  
Compliant

Programs PIC  
MCUs including  
low-voltage (3.3V)  
devices

Includes:

Programmer, USB Cable,  
ZIF Programming Adapter for 8 to 40-pin DIP,  
Software for Windows 98/Me/NT/2K/XP



EPIC<sup>™</sup> Parallel  
Port Programmer  
starting at \$59.95

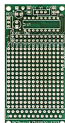
### LAB-X Experimenter Boards



Pre-Assembled Board  
Available for 8, 14, 18, 28,  
and 40-pin PIC<sup>®</sup> MCUs  
2-line, 20-char LCD Module  
9-pin Serial Port  
Sample Programs  
Full Schematic Diagram

Pricing from \$69.95 to \$349.95

### PICPROTO<sup>™</sup> Prototyping Boards



Double-Sided with Plate-Thru Holes  
Circuitry for Power Supply and Clock  
Large Prototype Area  
Boards Available for Most PIC<sup>®</sup> MCUs  
Documentation and Schematic

Pricing from \$8.95 to \$19.95

### BASIC Compilers for PICmicro<sup>®</sup>



Easy-To-Use BASIC Commands  
Windows 9x/Me/2K/XP Interface

PICBASIC<sup>™</sup> Compiler \$99.95  
BASIC Stamp 1 Compatible  
Supports most 14-bit Core PICs  
Built-In Serial Comm Commands

PICBASIC PRO<sup>™</sup> Compiler \$249.95

Supports All PICmicro<sup>®</sup> MCU Families  
Direct Access to Internal Registers  
Supports In-Line Assembly Language  
Interrupts in PICBASIC and Assembly  
Built-In USB, I2C, RS-232 and More  
Source Level Debugging

See our full range of products, including  
books, accessories, and components at:

[www.melabs.com](http://www.melabs.com)



# We Have Them All!

We do not just boast of being the leading site on the internet for the best selection of electronic development and prototyping products for engineers, hobbyists, and educational programs. We ARE the leading distributor of educational microcontroller boards and peripheral circuits in the U.S. Our boards are of high quality and the lowest price, compared to our competitors. Finally, you get *full technical support* with every board you buy. Take a look on what we have and then visit our website: **www.world-educational-services.com**. Remember, you do not need 34 LEDs and 34 switches on your board to experiment. *All our boards come with LCD, power supply, in-circuit programmer (wherever required), wiring kit and software CD.* We carry a full line of add-on boards.



NX-877 (PIC)  
**\$99.00**



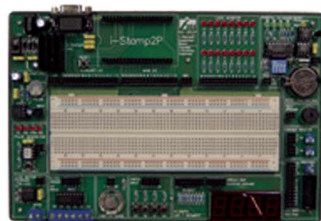
MCS-51  
**\$149.00**



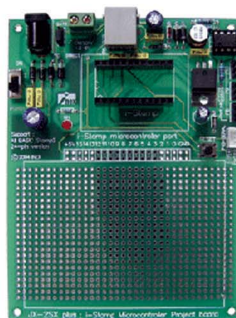
Basic STAMP  
**\$65.90**



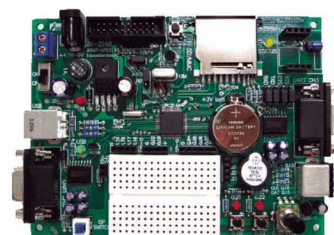
Javelin Dev. Board  
(incl. Jav STAMP)  
**\$150.00**



Basic STAMP Dev. Board  
**\$130.00**



Basic STAMP ProtoBoard  
(includes 2SX)  
**\$45.00**



JX-2148 Arm7  
**\$85.00**

**We also carry the dsPIC30F2010 for \$100.00 and the PSoC for \$80.00.  
Both are not pictured above.**

## WORLD EDUCATIONAL SERVICES

**3093 C Beverly Lane, Cambridge, MD 21613**

**Phone: 410-228-7666 Fax: 410-228-7553 Email: [masc1@usa.net](mailto:masc1@usa.net)**

*Visit our website for wonderful products of our PICAXE line:*

**[www.world-educational-services.com](http://www.world-educational-services.com)**





# GETTING STARTED WITH PICs

## THE LATEST IN PROGRAMMING MICROCONTROLLERS

■ BY CHUCK HELLEBUYCK

## PIC12F675 REPLACES THE 555 TIMER

**IF YOU HAVE BEEN FOOLING WITH ELECTRONICS** as long as I have, you will have seen a lot of changes throughout the years. I watched the birth of integrated circuits which led to op-amps and TTL or CMOS digital chips, and eventually to the microcontroller. Somewhere along the way, an eight-pin chip used by hobbyists all over the world was developed.

**T**his little eight-pin chip was known as the 555 timer (shown as a block diagram in Figure 1). It would be the main building block of many electronic projects. Even Forrest Mims who wrote most of those RadioShack project books many years ago used the 555 in various applications. By just adding a few external capacitors and resistors plus an occasional diode, you could make the 555 chip do amazing things. Though some still use the 555, I've found that the eight-pin PIC microcontrollers can do everything a 555 can do and more.

Many years ago, Microchip released the first eight-pin microcon-

troller and I was blown away. To have all the power of a PIC inside a small eight-pin package was just amazing. I began to think of all the 555 applications it could replace and do so much more yet not take up any more space. In fact, it would take less space since all the external capacitors, resistors and diodes were replaced by software. The early eight-pin PICs were limited in their features but were still far more powerful than a 555. As the years have gone by, more powerful eight-pin PICs have been released. The only problem with all this was you needed to know how to program the microcontrollers in order to use them. That was a huge hurdle for many people including me. But with the release of PICBasic Pro and other PIC compilers, low-cost PIC programmers such as my EZPIC programmer, and lots of sample code for PICs, it's not nearly as difficult to use a PIC in place of a 555.

One of the 555 projects I built was a large LED countdown clock for my nephew about 15 years ago that had a 555 oscillator at the heart of it. He wanted this for his annual roller hockey birthday party. He was 11. I knew it wasn't very accurate since it was really based on a resistor-capacitor charging scheme that was greatly affected by temperature and voltage variation but it was good enough for a street hockey game. I built it with a potentiometer so I could

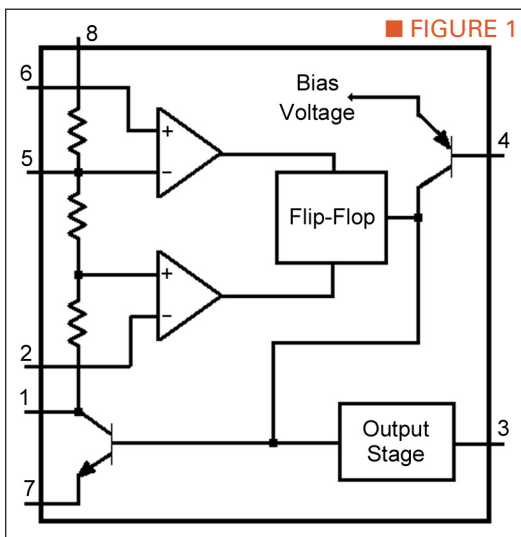
adjust the accuracy but never showed him how to do that. Then one day, several months after the party, he used it to time a speech he had to do for school. He called me in a panic because he thought he had broken something. The clock was really inaccurate. I had to explain to him about how it worked and the reason for its inaccuracy and comforted him that he didn't break it. I was more surprised that he used it and thought to myself how I should have built it with a crystal-based oscillator instead. It wasn't long after that I started getting into PICs.

He recently told me he still has that old thing which got me thinking. With an eight-pin PIC and crystal accuracy, I could build a *really* accurate time base. I could even add temperature compensation using an A/D port to read a temperature sensor. It also got me thinking about all those old 555 circuits I used to build such as a one-shot (monostable multivibrator) and clock oscillator (astable multivibrator). I even found an old Forrest Mims circuit book that used the 555 to drive LEDs in sequence through a 7441 decoder driver TTL IC. All these are so easy to do with a PIC, I realized that there really wasn't any need to use a 555 anymore.

For this article, I'll show you how to build a simple 555 one-shot replacement circuit using an external interrupt. I will also have it act as a pulse generator sending a 50% duty cycle signal out another output pin at the same time to cover another 555 good-

### NOTE:

■ The complete software listing is available on the *Nuts & Volts* website at [www.nutsvolts.com](http://www.nutsvolts.com)



ie. (These were popular 555 projects in their day.) I will use the PICBasic Pro compiler and the PIC12F675 eight-pin PIC (Figure 2) for both of these projects.

You can get a PIC12F675 for around \$1 in small quantities at various sources including **Microchipdirect.com**. You can even get a free sample from Microchip. I like this part since it's a 14-bit core PIC which is the same as the 16F876A that I like to use in my Ultimate OEM module and it has the extra stack levels. Most compilers including PICBasic Pro offer more commands on PICs with larger stacks. Some of the other eight-pin PICs Microchip offers are 12-bit core and only have a smaller stack. PICBasic Pro will work with these but some commands are not available.

Another big advantage to the PIC12F675 is the on-board Analog-to-Digital (A/D) converter. The 12F675 also has a comparator, 128 bytes of internal EEPROM, 64 bytes of RAM for variables, and 1K of Flash memory for the program. It even has a built-in 4 MHz oscillator option so you don't need an external resonator to run it. On all the eight-pin PICs, the MCLR pin has the option to internally pull the reset line high allowing that pin to also be used as an I/O pin. Therefore, this is a PIC that only requires five volts and ground to make it run.

All these features add complexity to the setup in the software so that will take a little explanation, especially the internal oscillator. So let's get that out of the way.

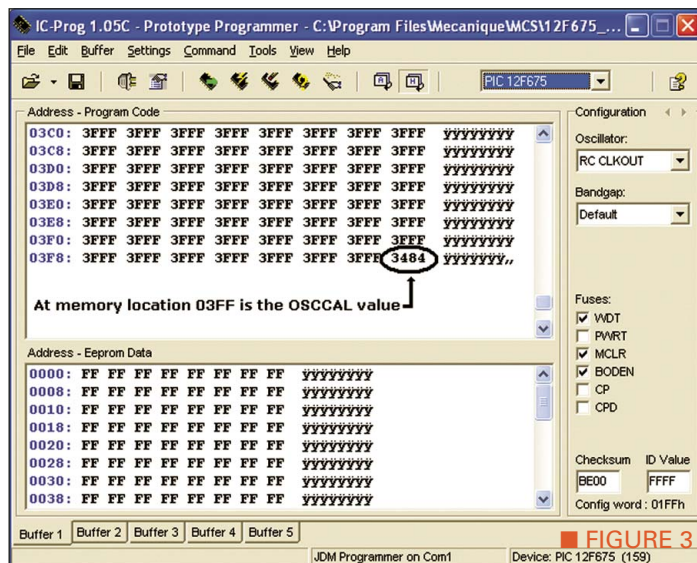
## INTERNAL OSCILLATOR

The 12F675 internal oscillator is built right into the silicon wafer that makes up the chip. The factory then calibrates the oscillator during the assembly process and they store a correction value at the last location of program memory. You need to use that value to get the most accurate clock possible. That requires you to be a little careful when programming it for the first time. I used my EZPIC programmer that I wrote about last year at this time, to program the PIC12F675. The software used is the ICPROG.exe freeware from IC-Prog.com. This software will first read the PIC12F675 to see what the value of the last location in memory is set to. You can see the value for the PIC I loaded in Figure 3.

If you write over that location, the calibration adjustment value will be lost. I recommend reading the chip and then writing it down on a small sticker to put on the bottom of the chip. This way you have the value even if it's erased. The ICPROG.exe software will even warn you before programming as seen in Figure 4. After it reads the PIC memory, it will ask if you want to use the calibration value read or the value in the .hex file you are trying to program into the PIC12F675. You can choose which one you want to use. In my program, I didn't set that location to anything so it showed up as 3FFF. Therefore, I chose to use the value read not the 3FFF value. The value is 3489 on this PIC12F675 while the previous screen in Figure 3 shows 3484. This is because I used two different PICs when I created these screen shots. This also shows how close the calibration values are from PIC to PIC. If you ever accidentally erase one, you can just read a different PIC12F675 and at



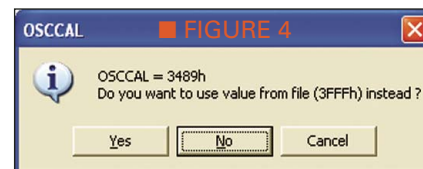
■ FIGURE 2



■ FIGURE 3

least be close.

You need to store that value in the OSCCAL register within the PIC to make the internal oscillator operate properly. PICBasic Pro handles this for you and I'll show you that in the code later. You also have to configure the PIC for the internal oscillator when it's programmed. You'll need to configure the MCLR pin for internal or external operation. You do that in the configuration register also at programming time. PICBasic Pro has an include file that automatically establishes this. It's called 12F675.inc and it's in the PICBasic Pro directory. I modified it to match the format below.



■ FIGURE 4

```
NOLIST
ifdef PM_USED
    LIST
    include 'M12F675.INC'          ; PM header
    device pic12f675, intrc_osc, wdt_on, mclr_off, protect_off
    XALL
    NOLIST
else
    LIST
    LIST p = 12F675, r = dec, w = -302
    INCLUDE "P12F675.INC"; MPASM Header
    __config _INTRC_OSC_NOCLKOUT & _WDT_ON & _MCLR_OFF &
    _CP_OFF
    NOLIST
endif
LIST N
```

The line INTRC\_OSC\_NOCLKOUT sets the internal oscillator mode. The MCLR\_OFF sets the MCLR pin to internal operation. There are a few other special registers I wanted to explain before jumping into the code.

## SPECIAL REGISTER SETUP

Because the PIC12F675 has few pins and lots of features, the various functions such as comparator and A/D are multiplexed connected to the actual metal pin. To select which ones





REGISTER 7-2: ANSEL – ANALOG SELECT REGISTER (ADDRESS:9Fh)

| U-0 | R/W-0 | R/W-0 | R/W-0 | R/W-1 | R/W-1 | R/W-1 | R/W-1 |
|-----|-------|-------|-------|-------|-------|-------|-------|
| —   | ADCS2 | ADCS1 | ADCS0 | ANS3  | ANS2  | ANS1  | ANS0  |

bit 7

bit 0

bit 3-0 ANS3:ANS0: Analog Select bits  
(Between analog or digital function on pins AN<3:0>, respectively.)  
1 = Analog input; pin is assigned as analog input<sup>(1)</sup>  
0 = Digital I/O; pin is assigned to port or special function

■ FIGURE 5

get connected requires you to set them up in software. The ANSEL (analog select) register and the CMCON (comparator control) register need to be set up at the beginning of your program so you know how the PIC is initially connected. For this project, I wanted both the A/D converter and comparator turned off and all the I/O pins in digital mode. To do that I first have to set up the ANSEL register to have the last four bits cleared to zero, as referenced in Figure 5.

The comparator requires the CMCON register to be set up for digital operation by putting the last three bits to their proper setting. In this case, setting them all to one disconnects the comparator and lets the pins be digital I/O (see Figure 6).

This probably seems a little confusing, but this along with a lot more information is all in the PIC12F675 data sheet. First projects are always the hardest.

## HOW IT WORKS

The project will just flash the green LED on GP0 at close to 5 Hz while waiting for the button to be pressed. This is a 5 Hz, 50% duty cycle clock much more accurate than the one I built for my nephew. When the button is pressed, a one-shot 250 msec pulse will be output on the GP1 pin thus briefly lighting the red LED and freezing the green LED in whatever state it is during that 250 msec. This will throw off the clock accuracy, but I really just wanted to show how easy it was to do these functions in software. The one shot output could be used to reset something so the clock may not need to be accurate at that point anyway.

## HARDWARE

The whole setup is shown in Figure 7 and the schematic is in Figure 8. It's really simple. I used one of my five-volt regulator breadboard modules to supply power to the rails. You could replace the 7805 circuit shown in the schematic with this. The project uses the internal pullups of the PIC to

keep the switch input on the interrupt pin GP2 high. The interrupt is set to trip on a falling edge. These are both set up in the software OPTION register. The PIC directly drives the LEDs.

## SOFTWARE

The software starts out very similar to other code I've written. I first define the oscillator speed at 4 MHz, then issue the special command that takes the OSCCAL value at the end of program memory and stores it into the OSCCAL register. This is a special PICBasic Pro DEFINE that is explained in the early part of the PICBasic Pro manual.

```
DEFINE OSC 4
DEFINE OSCCAL_1K 1
```

Next, those special register setups are established as we talked about earlier. Comparators are turned off and the A/D is not connected to the outside pins.

```
CMCON = 7
ANSEL = 0
```

Now the I/O is set up. The eight-pin PICs use a different name for the I/O so the register to control is the TRISIO register. Bits set to 1 are inputs; bits set to 0 are outputs. Since there are only six I/O, it doesn't matter what the leftmost bits are set to.

```
TRISIO = %00111100 'GP2-5 Inputs, GP1,0 Outputs
```

There is a special register just for the pull-up resistors. It's the WPU (weak pullup) register. A 1 enables the pull-up and a 0 disables it. This is nicer since you can set each pull-up individually here, but the 16F876A is all on or all off. This doesn't turn them on yet. That is done in the OPTION register.

```
WPU = %00000100 ' GP2 Pull-up Enabled
```

I initialize all the I/O to low by directly writing to the GPIO port. In looking at this, I should have done this before setting the TRISIO register. It will work but occasionally the LEDs may initially flash on.

```
GPIO = 0 ' All Ports Low to Start
```

The OPTION register does a lot of things but here we only need to turn on the internal pull-ups and set the direction for the interrupt to the falling edge (high to low).

```
OPTION_REG = %00000000 ' Internal Pull-ups
enabled, ' Trigger on Falling
' Edge
```

The interrupt control register enables only the external interrupt by setting the fifth bit. The eighth bit turns all interrupts on.

```
INTCON = %10010000 ' Enable External Interrupt
```

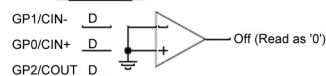
CMCON – COMPARATOR CONTROL REGISTER (ADDRESS:19h)

| U-0 | R-0  | U-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |
|-----|------|-----|-------|-------|-------|-------|-------|
| —   | COUT | —   | CINV  | CIS   | CM2   | CM1   | CM0   |

bit 7

bit 0

Comparator Off (Lowest power)  
CM2:CM0 = 111



■ FIGURE 6

The ON INTERRUPT command is issued to tell the program where to go when an external interrupt occurs. This command makes interrupts very easy.

```
ON INTERRUPT GOTO pulse  \ Create
                          \ Interrupt
```

The main loop is simple — just flash an LED like we've done before.

```
Main
  High 0      \ Send continuous 5 Hz
  pause 100   \ 50% duty cycle
  low 0       \ clock pulse out
  pause 100   \ pin GP0
  goto Main
```

The interrupt routine is also quite easy. We first DISABLE any future interrupts while the handler is functioning. This is hardly an issue since it will run a lot faster than a person can press the switch, but this also helps to not react to switch bounce multiple times.

```
\ *** Interrupt handler routine ***
DISABLE
```

The interrupt handler just pulses the GP1 pin for 250 msec. This is where you can easily adjust the one-shot timing without having to change resistors or capacitors like you would with a 555.

```
pulse:
  high 1      \ Send 250 msec pulse
  pause 250   \ out the GP1 pin
  low 1
```

We have to clear the interrupt flag before leaving the interrupt and then issue the RESUME and ENABLE commands.

```
INTCON.1 = 0      \ Clear interrupt flag
RESUME
ENABLE
```

Short and simple and our 555 one-shot replacement with a side of 5 Hz oscillator is ready to go. This took so little code space. Only 98 of 1,024 words of program memory were used.

## CONCLUSION

As you can see, the PIC12F675 is a handy little part. PICBasic Pro comes through again to make the software easy. This program can be expanded in so many ways. With the SEROUT/SERIN command in PICBasic Pro, you can make any pin a serial communication pin. Add a large memory eight-pin EEPROM using the I2COUT/I2CIN commands to a 12F675 and you have memory storage. Add a temperature sensor to an A/D pin and you have only

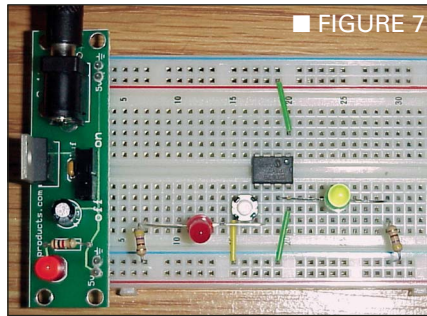


FIGURE 7

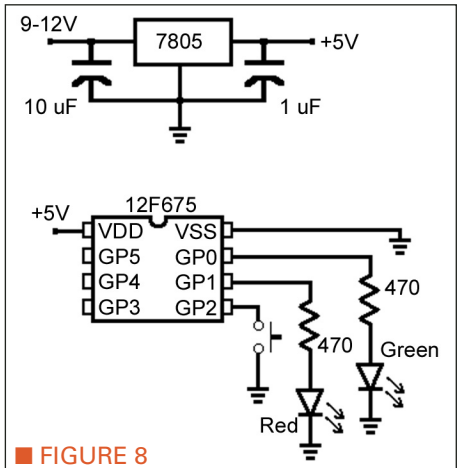


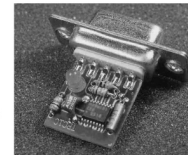
FIGURE 8

used five of the six pins.

One thing I did not mention is the I/O limitation. If you look in the data books, you will see that the GP3 pin is an input only pin so you really have only five outputs and six inputs with this chip. Five is all you need though to make the small temperature data logger that I just described. Give it a try and let me know through email how it worked. Send any comments about the articles to [chuck@elproducts.com](mailto:chuck@elproducts.com). I like getting the feedback. You can also visit my website at [www.elproducts.com](http://www.elproducts.com) for the EZPIC programmer and the 5V regulator breadboard module. I have a whole bunch of new ideas for 2007, so stay tuned. **NV**

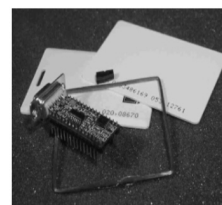
## \$25 EVAL (QTY 1) \$7.10 OEM (1K) TINY PC!

TPC1 is a functional computer complete with CPU, memory and I/O. Not a DIP module, core or "engine". No special cables or development kits to buy. Download programs with XP Hyperterm. Micro-power, run from serial line or battery.



1/2" FORM FACTOR!  
RUN X86 ASSEMBLY,  
TURBO C OR QBASIC.  
EASY TO USE!

- Built-in FLASH, RAM, EE
- Up to 6 serial or parallel I/O
- On-board diagnostic LED
- PC compatible BIOS routines
- Hardware Real-Time-Clock
- Up to 4 channels 12bit ADC
- Ready to go DB9 connector
- TPC2 (more mem/io) \$50/\$14

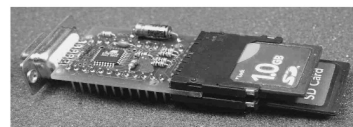


## RFID MODULE \$7

New lower cost unit has longer range and reads more tag types than competitive units. On-board power FET drives solenoid directly with card qualify functions. Serial out.

RFID2 eval (qty 1) \$25, oem (1k) \$7.10

## RS232 TO SD FLASH



HALF THE SIZE, HALF THE COST, TWICE THE VALUE!

Read/Write PC compatible media with Stamp, Z80, AVR, PIC micros. Up to 128 files at once 16 gigabyte max size.

SD1 oem (1k) price \$11.35, SD2 \$75/\$21 **\$39.95** single piece price

**WWW.STAR.NET/PEOPLE/~MVS**  
Alternate: [WWW.GEOCITIES.COM/MEGAMVS](http://WWW.GEOCITIES.COM/MEGAMVS)

Call or visit website  
for more information  
(508) 792 9507



5yr Limited Warranty  
Free Shipping  
Mon-Fri 10-6 EST



# CLASSIFIEDS

## COMPONENTS



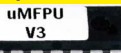
### RF PARTS™ CO.

Tubes, Transistors, Power Components  
Email: [rfp@rfparts.com](mailto:rfp@rfparts.com) • Web: [www.rfparts.com](http://www.rfparts.com)

800-737-2787 Fax 888-744-1943

#### Floating Point Coprocessor

New



**uM-FPU V3**  
32-bit IEEE 754, SPI and I2C interface  
10 to 70 times faster than uM-FPU V2  
new instructions: matrix, FFT, string,  
12-bit A/D, Flash, EEPROM,  
callable user-defined functions  
2.7V, 3.3V or 5V, with low power mode  
18-pin DIP or SMT, RoHS compliant  
uM-FPU IDE code compiler, debugger,  
user-defined function programmer  
Applications: sensors, GPS, robotics,  
signal processing, embedded control  
See website for full details  
[www.micromegacorp.com](http://www.micromegacorp.com)

#### LEDs

Super Brights from 20¢  
RGB Color Mixing 30 Pack \$6.99  
Assortment 120 Pack \$24.99  
Shipping from \$3.00  
[Alan-Parekh.com/Store](http://Alan-Parekh.com/Store)

#### PLANS/KITS/SCHEMATICS

### QKITS.COM



**K8063 - LED Display Kit w/ Serial Interface**

Electronic Kits & Test Equipment

1-888-GO 4 KITS

FREE SAMPLES!

[www.invents.net](http://www.invents.net)

Search for [invents.net](http://www.invents.net) on  
Yahoo! or Ask.com

### Electronic Kits

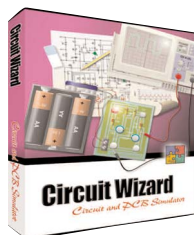
- Fun and Educational
  - Discount White and Blue LEDs
  - Quantity Discounts
- [www.bakatronics.com](http://www.bakatronics.com)

#### FREE 120 Pg CATALOG

Electronic components, kits,  
test equipment, tools, and sup-  
plies for hams, hobbyists, and  
businesses. Many hard-to-find  
items like variable capacitors,  
vernier dials, coil forms, magnet  
wire, and toroids.  
Ocean State Electronics  
[www.oselectronics.com](http://www.oselectronics.com)

#### PCB SOFTWARE

#### EXCLUSIVE U.S. DISTRIBUTOR



### YOUR COMPLETE SOLUTION!

- PCB Design
- PCB Simulation
- CAD/CAM Menu

121747, Hobby Vers., \$175  
121743, Pro. Version, \$275

[www.KELVIN.com](http://www.KELVIN.com)

[www.nutsvolts.com](http://www.nutsvolts.com)

## CONNECTORS/WIRE/CABLE



**The RF Connection**  
213 N. Frederick Ave., Ste. 11N  
Gaithersburg, MD USA 20877  
[http://www.therfc.com/](http://http://www.therfc.com/)

#### Complete Selection of MIL-Spec Coax, RF Connectors and Relays

UG-21B/U N Male for RG-213/214 \$.500  
UG-21D/U N Male for RG-213/214 \$.325  
N Connectors for 9913/Flexi4XL/9096  
UG-21B/9913 .....\$6.00 / Pins Only.....\$1.50  
UG-21D/9913 .....\$4.00 / Extra Gasket\$.075  
Amphenol 83-1SP-1050 PL-259 \$.090  
UG-176/U Reducer RG-59/8X, \$.025  
or 5/1.00  
UG-175/U Reducer RG-58/58A, \$.025  
or 5/1.00  
Silver Teflon PL-259/Gold Pin, \$1.00  
or 10/\$9.00

MIL-Spec Coax Available (Teflon, PVC IIA)  
New Product: Belden 9913F, 9913 with  
High Density PE Foam dielectric,  
stranded center cond. and Duobond  
III Jacket \$.80/ft or \$.76/00/100ft  
Also New: 9092, RG8X with Type II Jacket.  
Intro Price .....\$23.00/100ft

#### Call for Specials of the Month

Full Line of Audio Connectors for Icom,  
Kenwood, and Yaesu  
8 Pin Mike Female \$2.50  
8 Pin Mike Male Panel \$2.50  
13 Pin DIN for Kenwood \$2.75  
8 Pin DIN for Icom \$1.00  
8 Pin DIN for Kenwood \$1.50

Prices Do Not Include Shipping

Orders 800-783-2666  
Info 301-840-5477  
FAX 301-869-3680

## SCSI

I-U320 50Pin-68Pin-80Pin  
1 to 8 Bay Case Enclosures  
Adapters Cables Terminators  
Low Prices - Qty Discounts!  
(Also FireWire, USB, Video)  
[www.mcpb.com](http://www.mcpb.com)

## AMATEUR RADIO

#### WIRELESS FIELD STRENGTH TESTER

With Periodic Log Periodic Antenna  
Detects Bugs & Hidden Cameras  
Identifies Hot & Cold spots  
Measures baseline RF levels  
Discovers hacker-site locations  
Aims & Aligns far-distant antennas  
Locates cable leaks & connector problems

**1 MHz to 8 GHz Bandwidth**  
DETECTS 5.8 & 2.4 GHz mW SIGNALS  
@ 20 ft. & PINPOINTS THEIR LOCATION

**Model ZC 300**  
SELECTABLE ANTENNA OPTIONS  
COAXIAL INPUT - For directional external antennas  
INTERNAL ANTENNAS - No adjustments needed

**LOG - MID - LINEAR DETECTION MODES**  
Weakest distant signals detected and location pinpointed

**DIGITAL/ANALOG SIGNAL DIFFERENTIATION**  
Enhanced call Phone, video, computer data  
& pulsed signal detection

**\$599** with directional 1.8-6.4 GHz Log Periodic Antenna

**ALAN BROADBAND CO.**  
93 ARCH ST.

REDWOOD CITY, CA 94062  
(650) 369-9627, (888) 369-9627  
FAX: (650) 369-3788

[WWW.ZAPCHECKER.COM](http://WWW.ZAPCHECKER.COM)

## ROBOTICS

### \$29.95 MaxSonar-EZ1

(MSRP) High Performance  
Ultrasonic Range Finder  
- serial, analog voltage  
& pulse width outputs  
- lowest power - 2mA  
- narrow beam  
- very easy to use!  
[www.maxbotix.com](http://www.maxbotix.com)

#### ROBOTIC

#### CONTROLLERS

Robot Bases, PIC, OOPic, Stamp,  
and Walking Machine Controllers.  
New ZIG-BEE RF-Link boards.  
Chips, kits, assembled.

[www.oricomtech.com](http://www.oricomtech.com)

### Dual 10A motor controller

- 6-24V Input
- 15A peak per channel
- Regenerative braking
- Analog, R/C and serial inputs
- Thermal and overcurrent protected

**\$79.99**

[dimensionengineering.com](http://dimensionengineering.com)

## PUBLICATIONS

### CNC Book

### Easy CNC

G-code  
Bit map draw programs  
Bit map image converter  
Bit map to G-code  
CAD - machine drawings  
CAM - DXF to G-code

<http://www.cncintro.com>

### SQUARE 1

### ELECTRONICS

(208) 664-4115  
Hayden, ID USA

## BUSINESS SERVICES

### Do You Repair Electronics?

For only \$9.95 a month, you'll receive a wealth of information:

Repair data for TV, VCR, monitor, audio, camcorder, & more.

Over 100,000 constantly updated problem/solutions plus...

- TechsChat live chat room.
- Private user discussion forums.
- Automated email list server.
- UL/FCC number lookup.
- Hot tips bulletin board.
- Manufacturer information.

To access RepairWorld, direct your internet browser to <http://www.repairworld.com>

## RepairWorld.com

Electronix Corp. 1 Herald Sq. Fairborn, OH 45324 (937) 878-9878



## CLASSIFIED ADVERTISING

**\$50.00 Per Inch — No extra charge for color.**

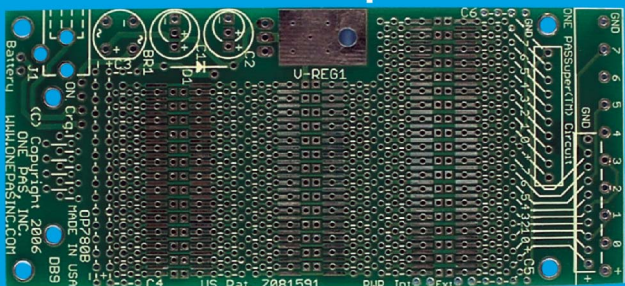
Classified ads must be paid in full prior to the closing date or the ad will be placed in the following issue, at our discretion. Minimum charge is one inch with half-inch increments. No proofs will be sent. Ads to be typeset by *Nuts & Volts*

must be received by the closing date. Supplied ads must be received by the artwork due date.

Call 951-371-8497 or email [classad@nutsvolts.com](mailto:classad@nutsvolts.com) for closing dates, available sizes, and special prepay discount offers.

## DESIGN/ENGINEERING SERVICES

### NEW ONE PASSuper™ Boards



[www.onepasinc.com](http://www.onepasinc.com)

### Product Design

### Free Quotes!

- Software
- Hardware
- Systems
- Low as \$250

[www.kadtronix.com](http://www.kadtronix.com)

\* Circuit board layouts

\* Prototype assemblies

[WWW.OSPREYELECTRONICS.COM](http://WWW.OSPREYELECTRONICS.COM)

Convert your sketch or print into a quality pcb for a reasonable price. Visit us on the web or call Osprey Electronics at (208) 664-1089 (USA)

Did you know that if you're a paid subscriber to *Nuts & Volts*, you can get the online version for **FREE**? Go to [www.nutsvolts.com](http://www.nutsvolts.com)

### HARDWARE WANTED

### DEC EQUIPMENT WANTED!!!

Digital Equipment Corp. and compatibles.  
Buy - Sell - Trade

CALL KEYWAYS 937-847-2300  
or email [buyer@keyways.com](mailto:buyer@keyways.com)

### LCDs/DISPLAYS



As low as \$9.18ea

- \* White text on Blue background 16x2 LCD
- \* High contrast & wide viewing angles
- \* HD44780 equivalent controller built-in
- \* Add serial converter kit for \$14.95ea.

Order online at:  
[www.411techsystems.com](http://www.411techsystems.com)

### SOLAR PRODUCTS

### BATTERY DESULFATORS

[www.wizbangplus.com](http://www.wizbangplus.com)

## AUDIO/VIDEO

[www.MATCO.com](http://www.MATCO.com)  
**Pocket Motion Video Recorder**  
MVC-1000-512M

- Built-in color pinhole camera
- Continuous 24 hr recording
- Built-in 512MB CF Card
- Up to 640 x 480 pixels adjustable resolution
- Up to 8 fps recording rate
- Composite Video output
- JPEG video format
- Motion Detection Recording mode with 99 sensitivity levels
- Memory Overwrite Function
- 12 VDC Power or 4 AA batteries

**Low Price \$249**  
7 days recording

Hidden Camera

Video Output Operation Panel

Dimensions: 4" H x 2.34" W x 1.38" D

(800)719-9605 [EverSecure@matco.com](mailto:EverSecure@matco.com)

[www.MATCO.com](http://www.MATCO.com)  
**4 Channel Real-Time DVR PC Card**  
**Convert Your PC to DVR**

- Real Time 30 fps displaying/recording for each channel
- Internet accessible
- Up to 640 x 480 pixels
- Local & Remote PTZ control
- Hardware video compression

DVRC-T14  
\$199/ea

(800)719-9605 [sales@matco.com](mailto:sales@matco.com)

### MICRO CONTROLLERS

### MicroStamp11

World's Smallest 68HC11 Microcontroller Module!



- telemetry
  - microrobotics
  - smart toys
  - animatronics
  - model railroading
  - home automation
- tiny (1 by 1.4 in.), light-weight (0.5 oz.)
  - on-board 5V reg., crystal, & reset chip
  - choice of 8K or 32K EEPROM
  - or 32K RAM + 32K EEPROM (64K version)
  - SCI, SPI, Output Compare and Input Capture channels, timer, pulse accumulator
  - all 14 I/O lines and 2 interrupt lines brought out to versatile 20-pin connector
  - program in BASIC, assembler, or C
  - easy code-loading with Docking Module
  - Starter Packages:
    - 8K EEPROM (#MS11SP8K)...\$49
    - 32K EEPROM (#MS11SP32K)...\$77
    - 32K EE/32K RAM (MS11SP64K)\$90

\* includes MicroStamp11, manual, PC software (assemblers, SBASIC compiler, MicroLoad utility, and sample programs), serial cable, Docking Module, & accessories.

[www.technologicalarts.com](http://www.technologicalarts.com)

Toll-free (USA & Canada):  
1-877-963-8996

Visa • MasterCard • Discover • Amex

[www.MATCO.com](http://www.MATCO.com)  
**Miniature size Video/Audio Transmitter Receiver Kit**

ASK-3004-TR  
2.4 GHz  
Amateur Frequencies  
4 Switchable Channels

**\$159**

1-800-719-9605

[www.MATCO.com](http://www.MATCO.com)  
**Wireless AV Transmitter/Receiver**  
140/kit

ASK-2008TR, 2.4, 1.7, 1.2 GHz, 8 Channel Wireless Systems

- Transmit range up to 800'
- 12 Channel Available
- Built-in channel switcher for auto scan
- 1000 mW booster optional

ASB-2000 2.4 GHz Power Amplifier

- Amplifies 2.4 GHz radio signal up to 1 W output
- 10-40 mW power input
- Size: 2" x 2" x 3/4" appr.
- Power Supply included

\$129/ea

(800)-719-9605 [EverSecure@MATCO.com](mailto:EverSecure@MATCO.com)

**Hitt Consulting**  
[www.hittconsulting.com](http://www.hittconsulting.com)

Serial 32MB SD Data Logger  
\$69.95 + \$5 s/h

Serial Video Generator Module  
\$33.95 + \$5 s/h

HC4LED SPI 4 Digit LED Display  
5 for \$15.00 + \$5 s/h

Consulting Service  
Design & Programming  
\$75/Hr

[info@hittconsulting.com](mailto:info@hittconsulting.com)

Looking for robots? Go to [www.servomagazine.com](http://www.servomagazine.com)

### SATELLITE

FREE Satellite TV Buyer's Guide

**Home of DishSkinz**  
C-band • Ku-band  
4DTV • MPEG-2

Get it all with just one call!

**800-500-9275**

**Skyvision**  
[www.skyvision.com](http://www.skyvision.com)

## MILITARY SURPLUS

Electronic Military Surplus



### Fair Radio Sales

Website: [fairradio.com](http://fairradio.com)  
E-mail: [fairradio@fairradio.com](mailto:fairradio@fairradio.com)  
Phone: 419-227-6573  
Fax: 419-227-1313  
2395 St Johns Rd  
Lima, OH 45804  
Visa, Mastercard, Discover  
Address Dept. N/V

30 Foot Mast Kit, \$139.50  
PRC-47 HF Transceiver, \$150.00  
6 Position Ant Tap Switch, \$3.95  
88MFD 1.2KV Capacitors, \$17.50  
URM-25 HF Signal Generator, \$110  
RT-834 Ground Radio 2-30MHz, \$300  
Yagi Antenna 928-960MHz, \$19.95  
ME-165 Power Meter 600W, \$125.00  
PRC-25 Backpack Radio, \$300.00  
HP-331A Distortion Analyzer, \$225  
5KV Doorknobs 10, 25, 50, 75pf, \$6 ea  
Various Velleman Electronic Kits

Many more items available  
See website for more info

Send for our Latest Catalog !!

Radios - Test Equipment - Tubes - Antennas

### PIC® Microcontroller Books

4 Titles

Beginner to Advanced

Table Of Contents

Ordering Info

On Web Site

<http://www.sq-1.com>

**SQUARE 1**

ELECTRONICS

(208) 664-4115

Hayden, ID USA



# The Nuts & Volts Hobbyist BOOKSTORE

## ELECTRONICS

### Practical Electronics for Inventors by Paul Scherz

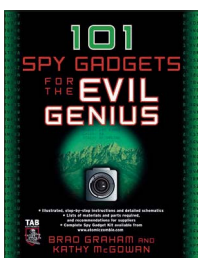
This intuitive, applications-driven guide to electronics for hobbyists, engineers, and students doesn't overload readers with technical detail. Instead, it tells you — and shows you — what basic and advanced electronics parts and components do, and how they work. Chock-full of illustrations, *Practical Electronics for Inventors* offers over 750 hand-drawn images that provide clear, detailed instructions that can help turn theoretical ideas into real-life inventions and gadgets. **\$39.95**



### 101 Spy Gadgets for the Evil Genius

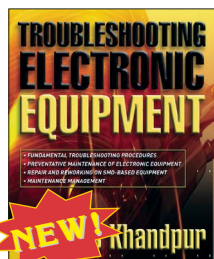
by Brad Graham/Kathy McGowan

Utilizing inexpensive, easily-obtainable components, you can build the same information gathering, covert sleuthing devices used by your favorite film secret agent. Projects range from simple to sophisticated and come complete with a list of required parts and tools, numerous illustrations, and step-by-step assembly instructions. **\$24.95**



### Troubleshooting Electronic Equipment by R. S. Khandpur

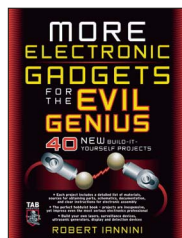
From cell phones to medical instruments to digital and micro-processor based equipment, this hands-on, heavily illustrated guide clearly explains how to troubleshoot, maintain, and repair all types of electrical equipment. The author covers all the essentials such as necessary tools, soldering techniques, testing, fundamental procedures, and mechanical and electrical components. **\$49.95**



If you don't see what you need here, check out our online store at [www.nutsvolts.com](http://www.nutsvolts.com) for a complete listing of the titles available.

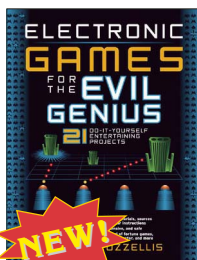
### MORE Electronic Gadgets for the Evil Genius by Robert E. Iannini

This much anticipated follow-up to the wildly popular cultclassic *Electronic Gadgets for the Evil Genius* gives basement experimenters 40 all-new projects to tinker with. Following the tried-and-true Evil Genius Series format, each project includes a detailed list of materials, sources for parts, schematics, documentation, and lots of clear, well-illustrated instructions for easy assembly. Readers will also get a quick briefing on mathematical theory and a simple explanation of operation along with enjoyable descriptions of key electronics topics. **\$24.95**



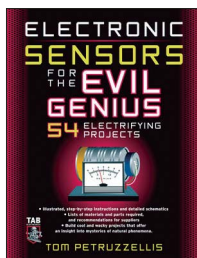
### Electronic Games for the Evil Genius by Thomas Petruzzellis

You can have a wicked amount of fun on your way to becoming a game master! In *Electronic Games for the Evil Genius*, popular how-to author Tom Petruzzellis gives you everything you need to build 35 exciting games and gadgets. You get complete, easy-to-follow plans, with clear diagrams and schematics, so you know exactly what's involved before you begin. Packed with fun projects that you'll love to build and play with, this guide develops game expertise one simple step and project at a time. **\$24.95**



### Electronic Sensors for the Evil Genius — 54 Electrifying Projects by Thomas Petruzzellis

Nature meets the Evil Genius via 54 fun, safe, and inexpensive projects that allow you to explore the fascinating and often mysterious world of natural phenomena using your own home-built sensors. Each project includes a list of materials, sources for parts, schematics, and lots of clear, well-illustrated instructions. Projects include rain detector, air pressure sensor, cloud chamber, lightning detector, electronic gas sniffer, seismograph, radiation detector, and much more. **\$24.95**



## PROJECTS

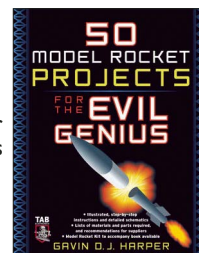
### LEGO MINDSTORMS NXT Hacker's Guide by Dave Prochnow

Here is an awesome next-generation collection of LEGO MINDSTORMS projects that enables you to build and program a real working robot in just 30 minutes! New technologies and expanded sensor capabilities make it easier than ever to add a level of sophistication to robotic and architectural creations. The book explains the all-new NXT intelligent brick ... the interactive servo motors with rotation sensors that align speed for precise control ... the ultrasonic sensor that allows robots to "see" by responding to movement ... the improved light and touch sensors that let robots detect color and feel ... and much more. **\$24.95**



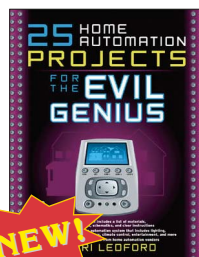
### 50 Model Rocket Projects for the Evil Genius by Gavin D J Harper

The fun, hands-on way to learn about rocket science. Yes, as a matter of fact, is IS rocket science! And because this book is written for the popular Evil Genius format, it means you can learn about this fascinating and growing hobby while having fun creating 50 great projects. You will find a detailed list of materials, sources for parts, schematics, and lots of clear, well-illustrated instructions. **\$24.95**



### 25 Home Automation Projects for the Evil Genius by Jerri Ledford

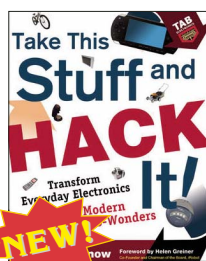
Computer technology has caught up with home automation, and it's now easy and inexpensive to automate everything in a house — including lighting, security, appliances, entertainment, and environmental conditions — and here's how to do it! This well-illustrated resource offers 25 complete home automation projects that require only basic household tools and the instructions found within its pages. **\$24.95**



CALL **1-800-783-4624** today!  
Or Order online @ **www.nutsvolts.com**

### Take This Stuff and Hack It! by Dave Prochnow

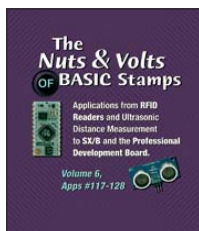
Transform common household items into really cool stuff. You don't need to be an electronics genius to get started turning everyday items into high-performing wonders. With how-to guru Dave Prochnow's step-by-step directions and fully illustrated plans, even beginners can hack their way to a high-tech home, cooler toys, and less yard work. Certain to fire your imagination and start you plotting new, original, and even more creative wonders you can make from ordinary household items, *Take This Stuff and Hack It!* is the perfect gift for your inner inventor. **\$27.95**



## MICROCONTROLLERS

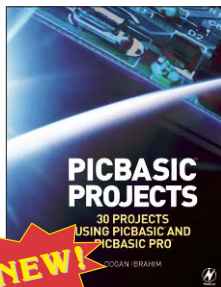
### Nuts & Volts of BASIC Stamps — Volume #6 by Jon Williams

Nuts & Volts of BASIC Stamps — Volume 6 includes articles #117-128, written for 2005. Article topics consist of RFID Readers and Ultrasonic Measurement, SX/B and the Professional Development Board, the advanced MIDI receiver, programming the SX microcontroller in BASIC, mastering the MCI4489 display driver, and more! The Nuts & Volts of BASIC Stamps books are a favorite Parallax technical pick and are a tremendous technical resource for all PBASIC programming projects. **\$14.95**



### PIC Basic Projects by Dogan Ibrahim

Covering the PIC BASIC and PIC BASIC PRO compilers, *PIC Basic Projects* provides an easy-to-use toolkit for developing applications with PIC BASIC. Numerous simple projects give clear and concrete examples of how PIC BASIC can be used to develop electronics applications, while larger and more advanced projects describe program operation in detail and give useful insights into developing more involved microcontroller applications. **\$29.95**



### Programming the PIC Microcontroller with MBASIC by Jack Smith

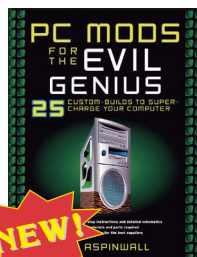
No microcontroller is of any use without software to make it perform useful functions. This comprehensive reference focuses on designing with Microchip's mid-range PIC line using MBASIC, a powerful but easy to learn programming language. It illustrates MBASIC's abilities through a series of design examples, beginning with simple PIC-based projects and proceeding through more advanced designs. **\$59.95**



## HOME COMPUTING

### PC Mods for the Evil Genius by Jim Aspinwall

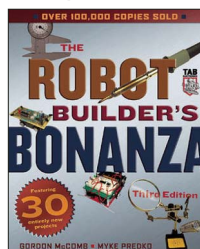
If you yearn for the coolest, most crazed 'puter around, *PC Mods for the Evil Genius* is the key to the kingdom! This book shows you how to supercharge your PC and create a jaw-dropping system that cannot be purchased off any shelf, anywhere! You get complete, easy-to-follow plans, clear diagrams and schematics, and lists of parts and tools, so you know what's needed before you begin. **\$24.95**



## ROBOTICS

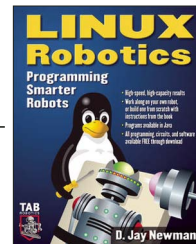
### Robot Builder's Bonanza Third Edition

by Gordon McComb/Myke Predko  
Everybody's favorite amateur robotics book is bolder and better than ever — and now features the field's "grand master" Myke Predko as the new author! Author duo McComb and Predko bring their expertise to this fully-illustrated robotics "bible" to enhance the already incomparable content on how to build — and have a universe of fun — with robots. Projects vary in complexity so everyone from novices to advanced hobbyists will find something of interest. Among the many editions, this book features 30 completely new projects! **\$27.95**



### Linux Robotics by D. Jay Newman

If you want your robot to have more brains than microcontrollers can deliver — if you want a truly intelligent, high-capability robot — everything you need is right here. *Linux Robotics* gives you step-by-step directions for "Zeppo," a super-smart, single-board-powered robot that can be built by any hobbyist. You also get complete instructions for incorporating Linux single boards into your own unique robotic designs. No programming experience is required. This book includes access to all the downloadable programs you need, plus complete training in doing original programming. **\$34.95**



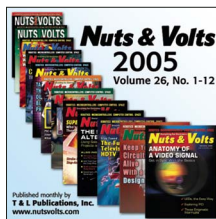
### SERVO CD-Rom

Are you ready for some good news? Along with the first 14 issues of *SERVO Magazine*, all issues from the 2005 calendar year are now available, as well. These CDs include all of Volume 1, issues 11-12, Volume 2, issues 1-12, and Volume 3, issues 1-12, for a total of 26 issues all together. These CD-ROMs are PC and Mac compatible. They require Adobe Acrobat Reader version 6 or above. Adobe Acrobat Reader version 7 is included on the discs. **\$24.95 – Buy 2 or more at \$19.95 each**



### Nuts & Volts CD-Rom

Here's some good news for *Nuts & Volts* readers! Along with all 12 issues of *Nuts & Volts* from the 2004 calendar year, the 2005 issues are now available, as well. These CDs include all of Volumes 25 and 26, issues 1-12, for a total of 24 issues (12 on each CD). These CD-ROMs are PC and Mac compatible. They require Adobe Acrobat Reader version 6 or above. Adobe Acrobat Reader version 7 is included on the discs. **\$24.95 – Buy 2 or more at \$19.95 each**



**WE ACCEPT VISA, MC, AMEX, and DISCOVER**  
Prices do not include shipping and may be subject to change. Ask about our 10% subscriber discount on selected titles.





# TECH



# FORUM

## This is a READER-TO-READER Column.

All questions *AND* answers are submitted by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. Questions are subject to editing and will be published on a space available basis if deemed suitable by the publisher. Answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

All questions and answers should be sent by email to [forum@nutsvolts.com](mailto:forum@nutsvolts.com) All *diagrams* should be computer generated and sent with your submission as an attachment.

### QUESTIONS

To be considered, all questions should relate to one or more of the following:

- ① Circuit Design
- ② Electronic Theory
- ③ Problem Solving
- ④ Other Similar Topics

■ Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).

■ Include your Name, Address, Phone Number, and email. Only your Name, City, and State will be published with the question, but we may need to contact you.

■ No questions will be accepted that offer equipment for sale or equipment wanted to buy.

■ Selected questions will be printed one time on a space available basis.

■ Questions are subject to editing.

### ANSWERS

■ Include in the subject line of your email, the question number that appears directly below the question you are responding to.

■ Payment of \$25.00 will be sent if your answer is printed. Be sure to include your mailing address or we cannot send payment.

■ Only your Name, City, and State, will be printed, unless you say otherwise. If you want your email address included, indicate to that effect.

■ Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

## >>> QUESTIONS

I am new to programming and need some advice on which assembly code is better to start out on. Almost every book on programming that I've seen, has a very generic, non-descript overview, so I have no idea where to start. What code should I learn? What book (or books) should I get?

**#1071**

**Andrew Hahn**  
via email

I'm looking for a phone call screener that would provide flexible control over incoming calls. A device that would allow me to enter phone numbers of acceptable callers that would ring the phone, but give all other calls a greeting and an option to leave voice mail. I have seen one product that asks the caller to enter a code, but this feature leaves out those whom I might have overlooked or forgotten when passing out the code. Does anyone know of a commercial product, kit, or design article?

**#1072**

**Al Davis**  
Hickory, NC

I have an antique agricultural tractor that has a 6 VDC electrical system. Because this tractor is no longer used like the daily workhorse it once was, I have to charge the battery every month or so. Of course, I never remember to

charge it ahead of when I want to start it up. To no avail, I have searched and searched for a 6 VDC battery charger/maintainer. I can find 12 VDC battery float chargers or maintainers; and in fact, I use these \$15 gems to maintain most of the lead-acid batteries that I have. I don't want to change the voltage of the electrical system on this tractor — defeats the purpose of having an "antique." Can you provide me a circuit that will maintain the voltage of 6 VDC lead-acid batteries? The circuit would stay plugged into the 110 VAC mains and monitor the battery voltage.

**#1073**

**Boyd Nielsen**  
Brooklyn, CT

What is the frequency and mode used by the small outdoor temperature transmitters? Is the data serial? Is there a standard format?

**#1074**

**Ron H**  
Wisconsin

**[#5065 - May 2006]**

## >>>> ANSWERS

I have a rear view camera from a 2004 Honda MDX. Other than the power and ground connections, there are leads for video, camera ground, shutter, and camera adap.(?). Placing an oscilloscope across the video and camera ground leads gives me horizontal blanking and sync pulses but no video.

I have placed a load resistor (75 ohms) across the video and camera ground terminals. Also, I have tried connecting five volts (through a 10 ohm limiting resistor) to the shutter and the camera adap. leads; but I still cannot see video information.

The Information is available from Honda's Service Site at <http://techinfo.honda.com>. The site is a subscription service: three days @ \$20; a month @ \$50; or a year for \$250. The Owners and User guides are free on this site, but for this kind of indepth info, you have to subscribe to get access to the Service Info area.

**Wesley Miller**  
Dillsburg, PA

### #9061 - September 2006

I have heard that fluorescent lights can be dimmed. The circuit is a constant voltage generator (120V) and a current controller that changes the frequency to lower the light intensity.

Can someone supply such a circuit that uses a variable frequency to change the amount of current flowing?

Fluorescent lights can be dimmed, but the main challenge in doing so is providing enough filament voltage to the light so the electrons can interact with the gas to emit light; usually about a 30-50% dimming is the max possible before the filaments lose heat and are unable to ignite the gas within the tube. For more details, visit Don Klipstein's website at <http://members.misty.com/don/f-dim.html>. He covers this topic and many other types of lights.

**Wesley Miller**  
Dillsburg, PA

### #11061 - November 2006

I need to build a timer that will let my tube amp warm up first and then connect the HV to the tube. I need a delay of 30 sec. Any schematic for the 555 or 4011?

**#1** One option available is to use Amperite 'G' series time delay relays. I mention this since they are in a glass envelope with pins on the bottom.

They can be pricey (\$96 each),

however if you are doing a tube amp with exposed tubes, I think this option may "class it up" a little with another tube on the base.

The Amperite 115C30 is designed for 115-volt operation. One drawback is that this has NC contacts rated at three amps; you could use these to control another relay hidden that can take the current for the high voltage transformer.

These can be ordered from Allied Electronics ([www.alliedelec.com/](http://www.alliedelec.com/)). Their part number is 892-1116.

**Craig Kielhofer**  
Kirkville, MO

**#2** I don't know much about your tube amp, but I hope this circuit (Figure 1) will help. This is a monostable circuit with a +5 VDC one amp linear power supply. The resistor and capacitor off of pin 2 triggers the timer approximately one second after applied voltage. The resistor and capacitor off of pin 6 and 7 times the 30 seconds. I used a potentiometer to get the 58K ohm. I threw in a relay on the output so you can have a wider range of control and you need to use the normally closed contact on the relay.

**Dustin Enns**  
Lehigh, KS

**#3** If I want to design a circuit around a 555 without doing math, I use a program named "555 Timer Pro." It can be downloaded from [www.schematica.com/555\\_Timer\\_design/555\\_Timer\\_PRO.htm](http://www.schematica.com/555_Timer_design/555_Timer_PRO.htm). The lite version is freeware and will do for all the basic stuff. The schematic in Figure 2 is from a print screen of this practical program and it will give you a 30s high pulse from a short low impulsions. You can attach to the output the commu-

tator you want, as long as it does not exceed the maximum current of your 555. Feel free to ask me any further questions at [jfduval@aqr.ca](mailto:jfduval@aqr.ca)

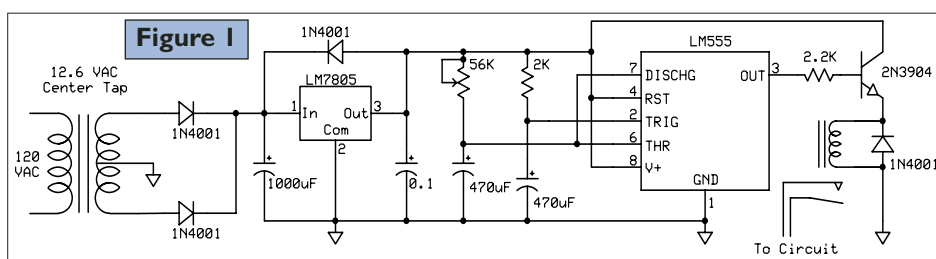
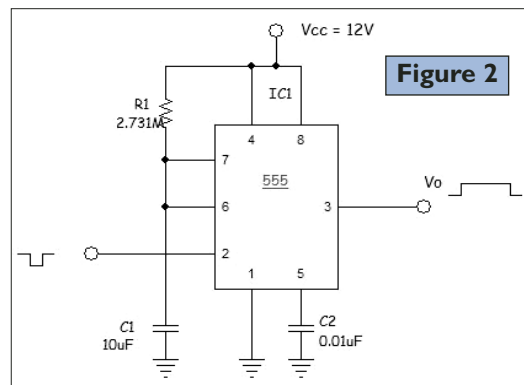
**JF Duval**  
Quebec, Canada

### [#12061 - December 2006]

Does a sound level meter record transient sounds as well as higher amplitude sounds originating from a fundamental frequency? In other words, if I strike a pan or piece of wood, the impulse excites some fundamental frequency along with transients. The amplitudes of the various transients have varying amplitudes and usually some "fundamental" frequency which may have a higher amplitude. Do the various frequencies "add up" along with the fundamental (within frequency range of an SPL meter) to produce a reading in dBs?

An SPL (Sound Pressure Level) meter is simply an amplified microphone fed through a bandpass filter and then displayed, giving you a reading in dB SPL. The combined frequency response characteristics of the microphone, amplifier, and filter are what's important. They are carefully tailored to mimic the frequency sensitivity of a human ear, known as A-weight. Some models also use a "flat" response, called C-weight.

In short, the meter can indicate





approximately how "loud" a sound seems.

And when it does this, it's "listening" to the entire spectrum that most humans hear, including transients, harmonics, fundamentals, and air-conditioner noise, too.

If it's important that you only observe or measure a certain portion of the audio spectrum, you can use an audio spectrum analyzer, also called a realtime spectrum analyzer. This is a device that will simultaneously display the acoustic energy of the entire audio spectrum broken down into much

finer bandpass segments. Some of the commonly available models for concert use have a resolution of one-third of an octave — that is, they have 31 discrete meters, indicating SPL for passbands from 20 Hz to 20,000 Hz. You can also obtain (free) spectrum analyzer computer programs for your PC that'll let you observe with a resolution of a few hundred Hz.

**Dan  
Pocatello, ID**

**[#12063 - December 2006]**

*I want to build an inexpensive,*

*simple, audio transmitting and receiving system (separate units) that can be connected to the stereo minijack output on an audio device/computer/etc., and the receiver connected to speakers that have a stereo minijack input. I would like to have multiple (3) receivers.*

Purchase a wireless FM transmitter. These are readily available today and although primarily designed to work with portable MP3 players, will work with any device with a headphone jack. A typical example is the Genovation Wireless FM Music Transmitter available from **Geeks.com** for \$8.99. [www.geeks.com/details.asp?invtid=GENOVATION-307&cat=MP3](http://www.geeks.com/details.asp?invtid=GENOVATION-307&cat=MP3) There is nothing special about this particular model. Any wireless FM transmitter will work. You should be able to find one at your local electronics or department store for about the same price. Some models will transmit the signal a longer distance.

Connect the FM transmitter to the headphone jack of the desired audio source. The receivers can be any type of portable FM broadcast receiver. The typical portable MP3/FM radio would make an excellent choice.

If you need more range, check out the professional FM transmitters at [www.Ramseyelectronics.com](http://www.Ramseyelectronics.com) such as the FM25B or FM30.

**John K3PGP**  
via email

## Full Speed It writes your USB Code!

### NEW! HIDmaker FS for Full Speed FLASH PIC18F4550

Creates complete PC and Peripheral programs that talk to each other over USB. Ready to compile and run!

- Large data Reports
- 64,000 bytes/sec per Interface
- Easily creates devices with multiple Interfaces, even multiple Identities!
- Automatically does MULTITASKING
- Makes standard or special USB HID devices

**NEW!** "Developers Guide for USB HID Peripherals" shows you how to make devices for special requirements.

Both PC and Peripheral programs *understand your data items* (even odd sized ones), and give you convenient variables to handle them.

**PIC18F Compilers:** PICBASIC Pro, MPASM, C18, Hi-Tech C.

**PIC16C Compilers:** PICBASIC Pro, MPASM, Hi-Tech C, CCS C.

**PC Compilers:** Delphi, C++ Builder, Visual Basic 6.

HIDmaker FS Combo: Only \$599.95



**DOWNLOAD the HIDmaker FS Test Drive today!**

[www.TraceSystemsInc.com](http://www.TraceSystemsInc.com)  
301-262-0300

M A D E L L T E C H N O L O G Y



**AT850B Hot Air Rework Station**  
**\$130.00**



**CA1640-20 20MHz Sweeping Function Generator/Frequency Counter**  
**\$260.00**



**STP-350 High Precision Manual Stencil Printer**  
**\$1195.00**



**AE-R330 Tabletop Convection Reflow Oven**  
**\$3950.00**



**QK702ESD 3-in-1 Rework Station**  
**\$449.00**



**1 GHz Spectrum Analyzer / Function Generator**  
**AT5011 \$1225.00**  
**AT5010 \$1025.00**  
**AT5010B \$875.00**



**AS-5001 Mini Automatic Reflow Oven**  
**\$798.00**



**SZM7045TR Trinocular Microscope with Double Bar Boom Stand \$590.00**  
**with Single Bar Boom Stand \$515.00**



**QK5020 20 MHz 2-Channel Analog Oscilloscope**  
**\$250.00**



**ZD-9556 Orbital Shaker \$265.00**

**www.madelltech.com**  
**Madell Technology Corp.** Toll Free: 877-670-9023  
 7372 Walnut Ave, Suite V Tel: 714-614-4896, 402-319-4101  
 Buena Park, CA 90620 Email: sales@madelltech.com



## **AMATEUR RADIO AND TV**

|                               |       |
|-------------------------------|-------|
| Atomic Time .....             | 44    |
| PolarisUSA Video, Inc. ....   | 11    |
| Powerwerx .....               | 10    |
| Ramsey Electronics, Inc. .... | 26-27 |

## **BATTERIES/ CHARGERS**

|                         |    |
|-------------------------|----|
| Cunard Associates ..... | 32 |
| Powerwerx .....         | 10 |

## **BUSINESS OPPORTUNITIES**

|              |    |
|--------------|----|
| EZ PCB ..... | 52 |
|--------------|----|

## **BUYING ELECTRONIC SURPLUS**

|                                   |    |
|-----------------------------------|----|
| Earth Computer Technologies ..... | 32 |
| GreenChip .....                   | 32 |
| Jaycar Electronics .....          | 59 |

## **CCD CAMERAS/ VIDEO**

|                                |         |
|--------------------------------|---------|
| Circuit Specialists, Inc. .... | 106-107 |
| Cosmos .....                   | 77      |
| Matco, Inc. ....               | 32      |
| PolarisUSA Video, Inc. ....    | 11      |
| Ramsey Electronics, Inc. ....  | 26-27   |

## **CIRCUIT BOARDS**

|                             |    |
|-----------------------------|----|
| Cunard Associates .....     | 32 |
| Dimension Engineering ..... | 39 |
| ExpressPCB .....            | 30 |
| EZ PCB .....                | 52 |
| Maxstream .....             | 6  |
| Micromint .....             | 68 |
| PCB Pool .....              | 70 |
| Pulsar, Inc. ....           | 32 |
| R4Systems, Inc. ....        | 71 |
| Saelig Company, Inc. ....   | 79 |
| Schmart Board .....         | 32 |

## **COMMUNICATION**

|                      |    |
|----------------------|----|
| Avcom Tec, LLC ..... | 17 |
|----------------------|----|

## **COMPONENTS**

|                                    |    |
|------------------------------------|----|
| Electronic Goldmine .....          | 53 |
| Electronix Express .....           | 92 |
| Front Panel Express LLC .....      | 85 |
| Jameco .....                       | 45 |
| Lemos International Co., Inc. .... | 17 |
| Linx Technologies .....            | 65 |
| Maxstream .....                    | 6  |
| Micromint .....                    | 68 |
| Pulsar, Inc. ....                  | 32 |

## **COMPUTER**

### **Hardware**

|                                   |    |
|-----------------------------------|----|
| ActiveWire, Inc. ....             | 32 |
| Earth Computer Technologies ..... | 32 |
| Halted Specialties Co. ....       | 69 |

### **Microcontrollers / I/O Boards**

|                             |            |
|-----------------------------|------------|
| Abacom Technologies .....   | 52         |
| Avcom Tec, LLC .....        | 17         |
| Conitec DataSystems .....   | 70         |
| EMAC, Inc. ....             | 64         |
| microEngineering Labs ..... | 92         |
| Micromint .....             | 68         |
| MVS .....                   | 97         |
| Net Media .....             | 2          |
| Parallax, Inc. ....         | Back Cover |
| R4Systems, Inc. ....        | 71         |

|                                      |        |
|--------------------------------------|--------|
| Scott Edwards Electronics, Inc. .... | 78     |
| Texas Instruments .....              | 7      |
| Trace Systems, Inc. ....             | 104    |
| World Educational Services .....     | 44, 93 |
| XGameStation .....                   | 32     |

### **Software**

|                             |    |
|-----------------------------|----|
| Pioneer Hill Software ..... | 78 |
|-----------------------------|----|

## **DESIGN/ ENGINEERING/ REPAIR SERVICES**

|                               |     |
|-------------------------------|-----|
| ExpressPCB .....              | 30  |
| EZ PCB .....                  | 52  |
| Front Panel Express LLC ..... | 85  |
| PCB Pool .....                | 70  |
| Pulsar, Inc. ....             | 32  |
| R4Systems, Inc. ....          | 71  |
| Trace Systems, Inc. ....      | 104 |

## **EDUCATION**

|                           |    |
|---------------------------|----|
| Avcom Tec, LLC .....      | 17 |
| Command Productions ..... | 17 |
| EMAC, Inc. ....           | 64 |
| Hobby Engineering .....   | 39 |
| Schmart Board .....       | 32 |
| XGameStation .....        | 32 |

## **ENCLOSURES**

|  |    |
|--|----|
| Integrated Ideas & Technologies, Inc. .... | 78 |
|--|----|

## **IP HOME AUTOMATION**

|                     |    |
|---------------------|----|
| MicroAutomata ..... | 24 |
|---------------------|----|

## **KEYBOARD EMULATORS**

|                            |    |
|----------------------------|----|
| Hagstrom Electronics ..... | 33 |
|----------------------------|----|

## **KITS & PLANS**

|                                      |       |
|--------------------------------------|-------|
| C & S Sales, Inc. ....               | 91    |
| DesignNotes.com, Inc. ....           | 25    |
| Earth Computer Technologies .....    | 32    |
| Electronic Goldmine .....            | 53    |
| Electronics123 .....                 | 32    |
| EMAC, Inc. ....                      | 64    |
| Hobby Engineering .....              | 39    |
| Information Unlimited .....          | 86    |
| Jaycar Electronics .....             | 59    |
| MicroAutomata .....                  | 24    |
| QKITS .....                          | 32    |
| RABBIT Semiconductor .....           | 3     |
| Ramsey Electronics, Inc. ....        | 26-27 |
| Scott Edwards Electronics, Inc. .... | 78    |
| XGameStation .....                   | 32    |

## **LASERS**

|                             |    |
|-----------------------------|----|
| Information Unlimited ..... | 86 |
|-----------------------------|----|

## **LSI (micon)**

|                               |    |
|-------------------------------|----|
| Renesas Technology Corp. .... | 31 |
|-------------------------------|----|

## **MISC./SURPLUS**

|                               |    |
|-------------------------------|----|
| All Electronics Corp. ....    | 66 |
| Electronic Goldmine .....     | 53 |
| Front Panel Express LLC ..... | 85 |
| GreenChip .....               | 32 |
| Halted Specialties Co. ....   | 69 |
| MCM .....                     | 43 |

## **MOTORS**

|              |    |
|--------------|----|
| Jameco ..... | 45 |
|--------------|----|

## **OPTICS**

|                         |     |
|-------------------------|-----|
| Madell Technology ..... | 104 |
|-------------------------|-----|

## **PCB MILLING MACHINES**

|                                |    |
|--------------------------------|----|
| LPKF Laser & Electronics ..... | 51 |
|--------------------------------|----|

## **PROGRAMMERS**

|                             |    |
|-----------------------------|----|
| Conitec DataSystems .....   | 70 |
| Electronics123 .....        | 32 |
| microEngineering Labs ..... | 92 |

## **PUBLICATIONS**

|                          |    |
|--------------------------|----|
| Mouser Electronics ..... | 29 |
|--------------------------|----|

## **RF TRANSMITTERS/ RECEIVERS**

|                           |    |
|---------------------------|----|
| Abacom Technologies ..... | 52 |
| Linx Technologies .....   | 65 |
| Matco, Inc. ....          | 32 |

## **ROBOTICS**

|                                    |    |
|------------------------------------|----|
| Budget Robotics .....              | 58 |
| CrustCrawler .....                 | 92 |
| Hobby Engineering .....            | 39 |
| HVW Technologies .....             | 32 |
| Jameco .....                       | 45 |
| LabJack .....                      | 17 |
| Lemos International Co., Inc. .... | 17 |
| Lynxmotion, Inc. ....              | 52 |
| Net Media .....                    | 2  |

## **SATELLITE**

|                                    |    |
|------------------------------------|----|
| Lemos International Co., Inc. .... | 17 |
|------------------------------------|----|

## **SECURITY**

|                             |    |
|-----------------------------|----|
| Cosmos .....                | 77 |
| Information Unlimited ..... | 86 |
| Linx Technologies .....     | 65 |
| Matco, Inc. ....            | 32 |
| PolarisUSA Video, Inc. .... | 11 |

## **SMT EQUIPMENT**

|                                |    |
|--------------------------------|----|
| LPKF Laser & Electronics ..... | 51 |
|--------------------------------|----|

## **TEST EQUIPMENT**

|                                     |         |
|-------------------------------------|---------|
| C & S Sales, Inc. ....              | 91      |
| Circuit Specialists, Inc. ....      | 106-107 |
| Conitec DataSystems .....           | 70      |
| DesignNotes.com, Inc. ....          | 25      |
| Dimension Engineering .....         | 39      |
| Electronic Design Specialists ..... | 58      |
| Jaycar Electronics .....            | 59      |
| LabJack .....                       | 17      |
| Link Instruments .....              | 5       |
| Madell Technology .....             | 104     |
| Pioneer Hill Software .....         | 78      |
| Protek Test & Measurement .....     | 25      |
| Saelig Company, Inc. ....           | 79      |
| Syscomp Design .....                | 32      |
| Trace Systems, Inc. ....            | 104     |

## **TOOLS**

|                                |     |
|--------------------------------|-----|
| C & S Sales, Inc. ....         | 91  |
| LPKF Laser & Electronics ..... | 51  |
| Madell Technology .....        | 104 |

## **WIRE, CABLE AND CONNECTORS**

|                            |    |
|----------------------------|----|
| DesignNotes.com, Inc. .... | 25 |
| Jameco .....               | 45 |
| Powerwerx .....            | 10 |

## **WIRELESS PRODUCTS**

|                     |    |
|---------------------|----|
| MicroAutomata ..... | 24 |
|---------------------|----|

|                                      |            |
|--------------------------------------|------------|
| Abacom Technologies .....            | 52         |
| ActiveWire, Inc. ....                | 32         |
| All Electronics Corp. ....           | 66         |
| Atomic Time .....                    | 44         |
| Avcom Tec, LLC .....                 | 17         |
| Budget Robotics .....                | 58         |
| C & S Sales, Inc. ....               | 91         |
| Circuit Specialists, Inc. ....       | 106-107    |
| Command Productions .....            | 17         |
| Conitec DataSystems .....            | 70         |
| Cosmos .....                         | 77         |
| CrustCrawler .....                   | 92         |
| Cunard Associates .....              | 32         |
| DesignNotes.com, Inc. ....           | 25         |
| Dimension Engineering .....          | 39         |
| Earth Computer Technologies .....    | 32         |
| Electronic Design Specialists .....  | 58         |
| Electronic Goldmine .....            | 53         |
| Electronics123 .....                 | 32         |
| Electronix Express .....             | 92         |
| EMAC, Inc. ....                      | 64         |
| ExpressPCB .....                     | 30         |
| EZ PCB .....                         | 52         |
| Front Panel Express LLC .....        | 85         |
| GreenChip .....                      | 32         |
| Hagstrom Electronics .....           | 33         |
| Halted Specialties Co. ....          | 69         |
| Hobby Engineering .....              | 39         |
| HVW Technologies .....               | 32         |
| Information Unlimited .....          | 86         |
| Integrated Ideas & Tech. ....        | 78         |
| Jameco .....                         | 45         |
| Jaycar Electronics .....             | 59         |
| LabJack .....                        | 17         |
| Lemos International Co., Inc. ....   | 17         |
| Link Instruments .....               | 5          |
| Linx Technologies .....              | 65         |
| LPKF Laser & Electronics .....       | 51         |
| Lynxmotion, Inc. ....                | 52         |
| Madell Technology .....              | 104        |
| Matco, Inc. ....                     | 32         |
| Maxstream .....                      | 6          |
| MCM .....                            | 43         |
| MicroAutomata .....                  | 24         |
| microEngineering Labs .....          | 92         |
| Micromint .....                      | 68         |
| Mouser Electronics .....             | 29         |
| MVS .....                            | 97         |
| Net Media .....                      | 2          |
| Parallax, Inc. ....                  | Back Cover |
| PCB Pool .....                       | 70         |
| Pioneer Hill Software .....          | 78         |
| PolarisUSA Video, Inc. ....          | 11         |
| Powerwerx .....                      | 10         |
| Protek Test & Measurement .....      | 25         |
| Pulsar, Inc. ....                    | 32         |
| QKITS .....                          | 32         |
| R4Systems, Inc. ....                 | 71         |
| RABBIT Semiconductor .....           | 3          |
| Ramsey Electronics, Inc. ....        | 26-27      |
| Renesas Technology Corp. ....        | 31         |
| Saelig Company, Inc. ....            | 79         |
| Schmart Board .....                  | 32         |
| Scott Edwards Electronics, Inc. .... | 78         |
| Syscomp Design .....                 | 32         |
| Texas Instruments .....              | 7          |
| Trace Systems, Inc. ....             | 104        |
| World Educational Services .....     | 44, 93     |
| XGameStation .....                   | 32         |



## PowerSupply1 Switching Power Supplies



New to **CircuitSpecialists.com** are these Highly Reliable, Universal AC input/full range single output power supplies. Choose between various 40, 60, 100 & 150 Watt versions. They have the approval of UL and cUL and come 100% full load burn-in tested and are protected with overload/over and voltage/short circuit. Also included is a 2 year warranty.

| PowerSupply1   | Qty 1   | Qty 10    | Qty 25    | Qty 100   | Qty 500   | Qty 1000  |
|--|---------|-----------|-----------|-----------|-----------|-----------|
| <b>40W Series</b><br>Available in<br>5,12,15,24,48V          | \$28.99 | \$26.09ea | \$24.53ea | \$21.95ea | \$15.98ea | \$13.79ea |
| <b>60W Series</b><br>Available in<br>5,12,15,24,48V          | \$32.99 | \$29.69ea | \$27.91ea | \$25.95ea | \$17.69ea | \$15.49ea |
| <b>100W Series</b><br>Available in<br>3.3,5,7.5,12,15,24,48V | \$38.50 | \$34.65ea | \$32.57ea | \$29.99ea | \$21.18ea | \$18.49ea |
| <b>150W Series</b><br>Available in<br>5,7.5,9,12,24,28,36V   | \$48.99 | \$44.09ea | \$39.00ea | \$37.50ea | \$26.93ea | \$23.49ea |

## Programmable DC Power Supplies

The CSI 3600 Series Programmable DC Power Supplies are equipped with a back-lit LCD display, number keypad and a rotary code switch for ease of use & quick programming. Voltage, Current & Power can all be displayed on the LCD or computer screen (with optional RS-232 interface module). It can be operated at constant current mode, constant voltage mode & constant power mode. It also can be set with maximum limits for current & power output. Ideal instruments for scientific research, educational labs or any application requiring a sophisticated DC-power source.



| Model       | CSI3644A | CSI3645A | CSI3646A |
|-------------|----------|----------|----------|
| DC Voltage  | 0-18V    | 0-36V    | 0-72V    |
| DC Current  | 5A       | 3A       | 1.5A     |
| Power (max) | 90W      | 108W     | 108W     |

**Only \$199.00 Each!**

[www.CircuitSpecialists.com](http://www.CircuitSpecialists.com)

## Circuit Specialists Soldering Station w/Ceramic Element & Separate Solder Stand

**\$34.95!**

- Ceramic heating element for more accurate temp control
- Temp control knob in F(392° to 896°) & C(200° to 489°)
- 3-prong grounded power cord/static safe tip
- Separate heavy duty iron stand
- Replaceable iron/easy disconnect
- Extra tips etc. shown at web site

Item#

**CSI-STATION1A** *Rapid Heat Up!*



## Also Available w/Digital Display & MicroProcessor Controller



Item#

**CSI-STATION2A**

**\$49.95**

Details at Web Site

> Soldering Equipment & Supplies > Soldering Stations

**SMD Hot Tweezer**  
Adaptor Fits CSI  
Stations 1A & 2A  
and CSI906

**\$29.00**

Item#

**CSITWZ-STATION**



**In Business**

**Circuit Specialists Inc.**

**Since 1971**



## Programmable DC Electronic Loads

The CSI 3700 series electronic loads are single input programmable DC electronic loads that provide a convenient way to test batteries and DC power supplies. It offers constant current mode, constant resistance mode and constant power mode. The backlight LCD, numerical keypad and rotary knob make it much easier to use. Up to 10 steps of program can be stored.



| Model         | CSI3710A  | CSI3711A  |
|---------------|-----------|-----------|
| Input Voltage | 0-360V DC | 0-360V DC |
| Input Current | 0-30A DC  | 0-30A DC  |
| Input Power   | 0-150W    | 0-300W    |

**CSI3710A: \$349.00**

**CSI3711A: \$499.00**

## 6-1/2 Digits Digital Multimeter

- Stability, Speed and Accuracy
- High Performance: 2000 readings/sec
- Multi-Point Scan
- 19 Full-Featured Functions
- Dual Displays with 3-color Annunciators
- Noise Immunity.
- Built-in USB and GPIB (optional) Interfaces
- Easy & Free PC applications
- 6 1/2 Digits M3500A Specifications
- Optional Accessories
- Designed with 7-1/2 digit techniques to provide user a stable, faster and accurate measurement.
- 1000VDC / 750VAC

**PICOTEST**



Compare Price & Specs with the Agilent 34410A!

**Item# M3500A**  
**\$689.00**

Details at Web Site

> Test Equipment > Digital Multimeters

## Protek Dual Trace 100MHz Oscilloscope

Outstanding performance and durability for an incredibly low price of \$519. You will find it at most other locations selling for \$975.

- Four traces may be simultaneously displayed in ALT-sweep
- Five vertical Modes Ch1, Ch2, Dual, Add and Subtract
- Bright 6" CRT with an internal graticule
- 12 kv acceleration voltage
- Sweep speeds to 2ns/Div.

**Limited Offer**  
**\$519.00!**

Item# **6510**



Details at Web Site > Test Equipment > Oscilloscopes/Outstanding prices

## Dual Output DC Bench Power Supplies

High stability digital read-out bench power supplies featuring constant voltage and current outputs. Short-circuit and current limiting protection is provided. SMT PC boards and a built-in cooling fan help ensure reliable performance and long life.

- Source Effect:  $5 \times 10^{-4} = 2\text{mV}$
- Load Effect:  $5 \times 10^{-4} = 2\text{mV}$
- Ripple Coefficient:  $< 250\text{uV}$
- Stepped Current: 30mA +/- 1mA

**HOT ITEM!**

\*All 3 Models have a 1A/5VDC Fixed Output on the rear panel\*

**CSI3003X-5:** 0-30v/0-3amp 1-4: **\$105.95** 5+: **\$99.50**

**CSI5003X5:** 0-50v/0-3amp 1-4: **\$114.95** 5+: **\$109.00**

**CSI3005X5:** 0-30v/0-5amp 1-4: **\$119.00** 5+: **\$114.00**

Details at Web Site > Test Equipment > Power Supplies



**As Low As**  
**\$93.00!**

## Triple Output Bench Power Supplies

with Large LCD Displays

- Output: 0-30VDC x 2 @ 3 or 5 Amps & 1ea. fixed output @ 5VDC@3A
- Source Effect:  $5 \times 10^{-4} = 2\text{mV}$
- Load Effect:  $5 \times 10^{-4} = 2\text{mV}$
- Ripple Coefficient:  $< 250\text{uV}$
- Stepped Current: 30mA +/- 1mA
- Input Voltage: 110VAC



**CSI3003X3:** 0-30VDCx2 @3A **\$188.00** 5+: **\$183.00**

**CSI3005XIII:** 0-30VDCx2 @5A **\$239.00** 5+: **\$229.00**

Details at Web Site > Test Equipment > Power Supplies

**ESD Safe CPU Controlled SMD Hot Air Rework Station**

The heater and air control system are built-in and adjusted by the simple touch of the front keypad for precise settings. Temperature range is from 100°C to 480°C / 212°F to 896°F, and the entire unit will enter a temperature drop state after 15 minutes of non-use for safety and to eliminate excessive wear.



**Sale**  
**\$149.00!**

- CPU Controlled
- Built-in Vacuum System
- Temperature Range: 100°C to 480°C / 212°F to 896°F
- 15-Minute Stand-By temperature "sleep" mode
- Power: 110/120 VAC, 320 W maximum

Item# **CSI825A++**

[Details at Web Site](#) > [Soldering Equipment & Supplies](#)

**Breadboard / Power Supply / MultiFunction DMM Bundle**

Provides the user with a quick and efficient system for breadboarding electronic circuits. Comes with three built-in regulated power supplies along with a deluxe, easy-to-use breadboard. Included is a multifunction DMM with 100VDC, 750VAC, frequency, resistance, diode test, audible continuity, transistor check, temperature, and capacitance.

**A Super Deal!**

[Details at Web Site](#)

> [Breadboards & Prototyping Boards](#)

**Powered Breadboard w/out DMM: \$69.00**



**Only**  
**\$69.99!**

Item#: **PBB272-DMM: \$69.99!**

**Powered Breadboard w/Multifunction DMM (CSIMS8264)**

**You Get The DMM for an Extra \$.99**

**Digital Storage Oscilloscope Module**

PC based Digital Storage Oscilloscope, 200MHz 5GS/s equiv. sampling USB interface

Convert any PC with USB interface to a high performance Digital Storage Oscilloscope. This is a sophisticated PC basedscope adaptor providing performance compatible to mid/high level stand alone products costing much more! Comes with two probes.

[Details & Software Download at Web Site](#)

> [Test Equipment](#) > [Oscilloscopes/Outstanding Prices](#)

**Price Breakthrough!**

Item# **200DSO** Only **\$819.00**

**SONY Super HAD CCD Color Weatherproof IR Cameras**

- Day & Night Auto Switch
- Signal System: NTSC
- Image Sensor: 1/3" SONY Super HAD CCD
- Horizontal Resolution: 480TV lines
- Min. Illumination: 0Lux

Item# **VC-827D:** **\$132.00**

**SONY Super HAD CCD™ equipped camera's feature dramatically improved light sensitivity**

**SONY Super HAD CCD B/W Weatherproof IR Camera**

- Day & Night Auto Switch
- Signal System: EIA
- Image Sensor: 1/3" SONY Super HAD CCD
- Horizontal Resolution: 420TV lines
- Min. Illumination: 0Lux

Item# **VC-317D: \$59.50**

[Details at Web Site](#)

**SONY Super HAD CCD Color Camera**

- Weather Proof
- Signal System: NTSC
- Image Sensor: 1/4" SONY Super HAD CCD
- Horizontal Resolution: 420TV lines
- Min. Illumination: 1Lux/F1.2

Item# **VC-805: \$53.95**

> [Miniature Cameras\(Board,Bullet,Mini's, B/W, Color\)](#)

**SONY Super HAD CCD Color Weatherproof IR Camera**

- Day & Night Auto Switch
- Signal System: NTSC
- Image Sensor: 1/4" SONY Super HAD CCD
- Horizontal Resolution: 420TV lines
- Min. Illumination: 0Lux

Item# **VC-819D: \$62.50**

**Stepper Motors**

| Part #:       | Motor Frame Size: | Holding Torque:  | Price:   |
|---------------|-------------------|------------------|----------|
| 42BYGH404     | NEMA 17           | 3.4kg.cm/47oz.in | \$17.95  |
| 57BYGH207     | NEMA 23           | 8kg.cm/111oz.in  | \$24.95  |
| 57BYGH303     | NEMA 23           | 15kg.cm/208oz.in | \$29.95  |
| 57BYGH405     | NEMA 23           | 20kg.cm/277oz.in | \$34.95  |
| 85BYGH350B-03 | NEMA 34           | 48kg.in/665oz.in | \$79.95  |
| 85BYGH350C-03 | NEMA 34           | 63kg.cm/874oz.in | \$119.95 |

**Stepper Motor Controllers 2 Phase Microstepping Stepper Motor Driver (Bi-polar & Unipolar Motors)**

| Part #: | Dimensions:         | MicroStep:  | Price:   |
|---------|---------------------|---|----------|
| XCW220  | 100mm x 61mm x 19mm | 1(200), 1/2(400), 1/4(800), 1/8(1600)   | \$39.95  |
| CW220   | 99mm x 65mm x 30mm  | 1/2(400), 1/8(1600)   | \$49.95  |
| CW230   | 115mm x 72mm x 32mm | 1(200), 1/2(400), 1/4(800), 1/8(1600), 1/16(3200), 1/32(6400), 1/64(12800)  | \$59.95  |
| CW250   | 140mm x 94mm x 45mm | 1(200), 1/2(400), 1/8(1600)   | \$69.95  |
| CW860   | 147mm x 97mm x 30mm | 1(200), 1/2(400), 1/4(800), 1/8(1600), 1/16(3200), 1/32(6400), 1/64(12800), 1/128(25600), 1/256(51200), 1/512(102400), 1/1024(204800), 1/2048(409600) | \$119.95 |

**Protek****Protek 2.0 & 2.9GHz Field Strength Analyzers**

- Frequency Range : 100KHz ~ 2900MHz (2060MHz for 3201N)
- WFM/NFM/AM/SSB modulated signals may be measured.
- Sweep Trigger Mode: Free Run, Single Run, Continuous Wave, Squelch Run
- Sweep Speed: 500 to 2000msec
- PLL tuning system for precise frequency measurement and tuning
- Built-in Frequency Counter
- RS232 interface

3290N



**New Rev. Now Available**

Item#s **3290N & 3201N**

[Details at Web Site](#)

> [Test Equipment](#) > [RF Test Equipment](#)

**Special**

**\$1899.00 (for 3290N)**

**\$1374.00 (for 3201N)**

**Protek****Handheld Spectrum Analyzer 2.9GHz**

- 100kHz to 2.9GHz measurement range
- Measures and demodulates W-FM/N-FM/AM/SSB signals
- Sweep mode(Free Run, Single Run, Squelch Run)
- PLL tuning system for precise frequency tuning
- 100 Saves and loads for waveforms and settings
- Enhanced Accuracy for Signal Level

Item# **PROTEK 7830**

[Details at Web Site](#)

> [Test Equipment](#) > [RF Test Equipment](#)

**Special**

**\$2988.00**



Visit our website for a complete listing of our offers. We have over 8,000 electronic items on line @ [www.CircuitSpecialists.com](http://www.CircuitSpecialists.com). PC based data acquisition, industrial computers, loads of test equipment, optics, I.C's, transistors, diodes, resistors, potentiometers, motion control products, capacitors, miniature observation cameras, panel meters, chemicals for electronics, do it yourself printed circuit supplies for PCB fabrication, educational D.I.Y. kits, cooling fans, heat shrink, cable ties & other wire handling items, hand tools for electronics, breadboards, trainers, programmers & much much more! **Some Deals you won't believe!**

**Circuit Specialists, Inc. 220 S. Country Club Dr., Mesa, AZ 85210**

**800-528-1417 / 480-464-2485 / FAX: 480-464-5824**



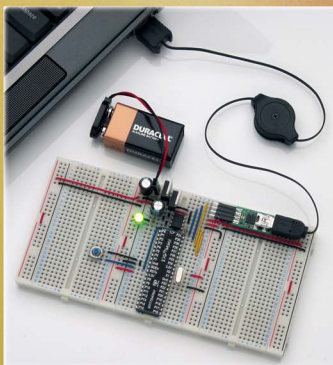
# Remember when programming was fun?



## Tired of what conventional chips have to offer? Ready to explore the possibilities without rules?

With eight 32-bit processors and real simultaneous multi-processing, the Propeller™ chip will take you back to when programming was seriously fun, instead of just serious.

| Propeller Chip Specifications |  |
|-------------------------------|--|
| Power Requirements            | 500 $\mu$ A/MIPS @ 3.3 volts DC                      |
| External Clock Speed          | DC to 80 MHz (4 MHz to 8 MHz with clock PLL running) |
| Internal RC Oscillator        | 12 MHz or 20 kHz                                     |
| System Clock Speed            | DC to 80 MHz   |
| Cogs                          | 8  |
| Performance                   | 20 MIPS per cog @ 80 MHz                             |
| Global RAM/ROM                | 32 KB RAM / 32 KB ROM                                |
| Processor RAM                 | 512 x 32 per cog                                     |
| I/O Pins                      | 32   |
| Current Source/Sink per I/O   | 30 mA  |



The **Propeller Education Kit** (#32305; \$79.95) A complete kit with everything you need to get started with the Propeller Educational Labs from Parallax; Packaged in a plastic storage box it includes a

Propeller DIP chip, breadboards, Propeller Clip, and circuit components.

*Find the Propeller Education Kit and many other Propeller chips, accessories, programming kits, sample code, and free downloads on our website.*



# PARALLAX

[www.parallax.com](http://www.parallax.com)

Place your order online or call our Sales Department toll-free at 888-512-1024 (Mon-Fri, 7am-5pm, PT).

Propeller and the propeller hat logo are trademarks of Parallax, Inc.